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Mazama:

A RECORD OF MOUNTAINEERING

...IN THE...

PACIFIC NORTHWEST.

CRATER LAKE NUMBER.

PORTLAND, OREGON:
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CONTENTS.

1.	Description of Crater Lake	Earl Morse Wilbur	139
2.	The Discovery and Early History of Crater Lake	M. W. Gorman	150
3.	The Geology of Crater Lake	J. S. Diller	161
4.	The August Vegetation of Mount Mazama, Oregon	Frederick V. Coville	170
5.	The Mammals of Mount Mazama, Oregon	C. Hart Merriam	204
6.	U. S. Fish Commission Investigations at Crater Lake	Barton Warren Evermann	230
7.	The Mazama's Outing of 1896	C. H. Sholes	239
8.	The Measurement of Altitudes	Henry Gannett	244
9.	Table of Corrections to the Readings of the Barometer	George Davidson	265
10.	Description of a Model Tent and Camping Outfit	Charles J. Fox	267
11.	Historian's Report for 1896	T. Brook White	271
12.	President's Address for 1896	C. H. Sholes	276
13.	Note and Comment		284
14.	Bibliography of Crater Lake		292
15.	List of Climbers of Mount Pitt		294
16.	Reports of Secretary and Treasurer		296

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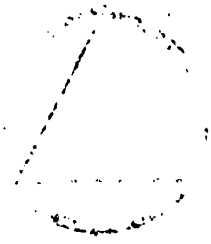

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CRATER LAKE, LOOKING NORTH.

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Description of Crater Lake.

EARL MORSE WILBUR.

If a vote of the well informed were taken as to what deserve to be called the seven greatest scenic wonders of the United States, there ought to be a substantial agreement upon the following: Niagara Falls, the Natural Bridge in Virginia, the Mammoth Cave in Kentucky, the geysers of the Yellowstone National Park, the Grand Canyon of the Colorado, the Yosemite Valley, and—Crater Lake, as to which there would be no shadow of doubt in the mind of any of the comparatively few who have ever felt the solemn spell that it casts upon all beholders. It would be idle to discuss which of these is the greatest wonder, each being so great of its kind; but there could be no discussion as to which is the most unique. There are cataracts that approach Niagara in the volume of water carried, and far exceed it in height; the Natural Bridge has a number of rivals in different parts of the country; the Mammoth Cave is simply the greatest among many great caverns; there are wonderful geysers elsewhere than in the Yellowstone; it has been said upon the highest authority that the "Snake river canyon compares favorably with even the most magnificent parts of the Grand Canyon of the Colorado, except that it lacks the gorgeous coloring to which so much of the charm of its southern rival is due"*; and recent explorers have described other valleys in the remote portions of the High Sierras as being even grander than the Yosemite; but there has not been discovered anywhere on the globe a lake which, except in the method of its formation, even remotely suggests comparison with Crater Lake in Oregon. Whether considered with regard to such features as impress themselves upon the mind of the casual visitor, or the many problems of absorbing scientific interest which it proposes for solution, Crater Lake has to share distinctions with no competitor. If it be asked why it is, then, that so wonderful a feature of natural scenery should up to now have remained unfamiliar, and all but un-

* Prof. Israel C. Russell, in *American Journal of Science*, March, 1897, vol. iii., p. 247.

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known, to the world at large, it must be answered that it is situated in a part of the country not yet much frequented by tourists, and within only a few years accessible to them at all by the usual means of travel; that it is hidden away in the mountains, several days' journey from a railroad; and that the people in its vicinity have done little by means of publication to make the world aware of its existence, much less appreciate its attractions. As related in the following article, the Lake has been known to white men since 1853, though so little known as to have been re-discovered several successive times before it was recognized as a permanent part of the geography of Oregon; and it was visited from time to time for thirty years and more by occasional persons or parties living within a radius of a hundred miles, and even by a few from great distances. Its fame became more permanent with the careful survey and study of it prosecuted by the United States Geological Survey in 1886, although no map of it was published until ten years later. While the expedition of the Mazamas, and the more extended study of the Lake by the Government Departments in 1896, drew to it a much larger number of people than ever before; and the accounts that have followed in periodical and scientific literature have done much more than had ever been attempted previously, to attract to it the public attention that it merits in its own right.

Crater Lake is situated on the summit of the Cascade Range in southern Oregon, about sixty-five miles north of the California boundary, and some twenty-two miles northwest of the now abandoned Fort Klamath. Its geographical location is a little southwest of the intersection of the forty-third parallel, north latitude, and the one hundred and twenty-second meridian, west longitude. The old military road leading from Jacksonville to Fort Klamath leads within about three miles of the Lake, and a passable mountain road leads from it up the steep slope of Mount Mazama to the very rim of the Lake.

The most favorable time for visiting the Lake is in July, August and September. Before the first of July snow may still make the roads impassable in some places as one gets near the Lake; and after the middle of October, at the latest, there is danger of snow storms coming on which might quite blockade the visitor.

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Mount Scott. Victor Cliff.

Photo. by M. M. Hazeltine.

LOOKING EAST FROM VICTOR ROCK.

The Watchman. Glacier Peak.

Photo. by M. M. Hazeltine.

LOOKING NORTHWEST FROM VICTOR ROCK.

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TABLE ROCK.

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The view is much finer early in the season than later, when the atmosphere is often thick with smoke from forest fires. The time when early fall rains have cleared the air is equally good; but the risk of rain storms or of a snow blockade is much greater.

There are three main routes by which one may reach the Lake from ordinary lines of travel, and each has its own attractions for the tourist. The shortest route leads from the Southern Pacific railroad at Medford (though the village of Central Point is the nearest railroad station), and follows up the valley of the Rogue river. Persons choosing this route can obtain comfortable conveyances and camping outfits at Medford or Jacksonville, and reach the Lake by easy stages in three days. The distance by this route is about eighty-five miles, and accommodations may be had on the road at Trail (28 miles) and at Prospect (52 miles), at the end of the first and second days; although at the Lake it is necessary to camp out. This road makes a gradual ascent, with few hard grades; but the last day is heavy with sand. It has been traversed by bicycles, but it can not be recommended to wheelmen. The road abounds in features of interest. Soon after leaving Medford, one passes Table Rock, a prominent mark in the landscape clearly visible from the railroad. This was the citadel of the Rogue river Indians, whom General Joseph Lane fought here in 1853. Further on one passes many beautiful reaches of the swiftly flowing river. Half a mile below Prospect the Lower Falls of Rogue river are crossed, a roaring cascade perhaps a third of a mile long, grand and impressive. At the foot of these falls, Mill Creek Falls are found, where Mill Creek plunges over an abrupt precipice a sheer 180 feet directly into Rogue river; and a few rods below these are Bear Creek Falls, smaller, but equal in height and not less beautiful. Above Prospect the road passes through some magnificent forests of Sugar Pine (*Pinus lambertiana*), whose trees, many of them not less than ten feet in diameter and 250 feet high, are second only to the Big Trees of California. Their giant cones, from twelve to eighteen inches in length, form striking souvenirs. About ten miles above Prospect, and a mile north of the road, the Natural Bridge may be visited, a bridge of basalt under which the whole volume of the river passes,

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to re-appear a few hundred feet below. A few miles farther on, the road passes close to the "Dalles" of Rogue river, which here flows through a narrow and deep basaltic gorge, followed by a series of rapids and a sheer fall of 186 feet. The last few miles before reaching the foot of Mount Mazama are through intermingled forests of Noble Fir (*Abies nobilis*) and Shasta Fir (*Abies magnifica*), whose conspicuous erect cones can not fail to attract attention from every beholder. Half a mile before reaching the summit of the Cascade divide, the road forks to the left, and the real foot of Mount Mazama is reached. The last three miles of the road make a rise of 1,000 feet or more up the slope of the mountain, until the rim of the Lake is reached.

A second route to Crater Lake is known as "the Dead Indian Road," which leaves the railroad at Ashland, and goes by the Lake of the Woods and Pelican Bay on Klamath Lake. Conveyances and camping outfits for those going this way may be had at Ashland. The distance this way is about ninety-seven miles, and may easily be covered in four days. There are no hotel accommodations on this road, and ranches at only three places to be of use to the camper. Leaving Ashland in the morning, one would best make the first camp at Hunt's Ranch (22 miles), the second at Pelican Bay (47 miles), and the third in the vicinity of Fort Klamath (72 miles). In order to make the ascent of Mount Pitt, 9,760 feet high, one may leave this road at the Lake of the Woods, or may follow up the abandoned military road leading up Four Mile Creek. This side trip and ascent can be accomplished in two days. The ascent is not difficult or dangerous; and the view from the summit is magnificent, embracing views of Mount Shasta, Diamond Peak, the Three Sisters and other lesser peaks, besides many beautiful lakes. At Pelican Bay the fishing is famous, and trout weighing as high as fifteen pounds are often caught there. Duck shooting is also exceedingly good in the vicinity at some seasons of the year. This road, like the one described above, can not be recommended to wheelmen. It crosses one range of mountains, and is often rocky; while the last fifteen miles are through deep sand. From this road it is a detour of but a mile or two to visit Fort Klamath, now abandoned, but occupying a situation of great beauty. This Fort is celebrated for

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its connection with the Modoc War of 1873, and the graves of Captain Jack and his companions, executed here at its close, are still to be seen. A further detour of five miles will take one to Klamath Agency, only a short distance from Williamson river, in which the trout fishing is said to be the finest on the Pacific Coast. The whole of the Klamath plain, from Pelican Bay to Fort Klamath, with its streams, icy cold and crystal clear, bursting full size from great springs, and flowing like a mill race between banks that are even full the year round, is one of unusual interest. After leaving Fort Klamath this road follows the course of Anna Creek, and for several miles runs along the brink of Anna Creek Canyon, which is carved from the tuff and volcanic conglomerate of the region, from 100 to 300 feet deep, and hardly more than half as broad. The views along its precipitous sides are often most striking. This road joins the one described above, just west of the Cascade divide, and about three miles from the rim of the Lake.

A third route leaves the railroad at Ager, Cal., and proceeds through Klamath Falls to Fort Klamath, where it joins the Dead Indian Road. This road is the longest of the three (116 miles), but the best to travel, and is reasonably good for wheelmen. There is a daily stage by this route from Ager to Klamath Falls, where one may obtain conveyances and camping outfits for the rest of the way. This road leads past Klamath Hot Springs, much resorted to for its mud and sulphur baths, and along Lower and Upper Klamath Lakes to Klamath Agency and Fort Klamath. One may take a side trip of two or three days from Klamath Falls to the Lava Beds, interesting on their own account, and made famous by the tragedy of the Modoc War. The distance from Klamath Falls to Crater Lake may be travelled in two days. †

In approaching Crater Lake, after making a steep climb for some three miles, one suddenly comes out upon a plateau, bordered with evergreen trees, and carpeted with various-hued flowers. There is at first no sign of a lake, and one only sees rising to right and left the peaks which form part of its rim. But proceeding across the plateau a few hundred yards, one finds oneself unexpectedly at the edge of a precipice, almost, at the foot of which,

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950 feet below, are the mysterious waters of the Lake. No words can express the emotions one feels at the first moment of discovery of the scene, so wonderfully combining the awful, the sublime, the mysterious and the beautiful. Strong men have burst into tears at the first view; brave men coming here alone have confessed that they fled away panic-stricken from the place, as fast as they could run. And nothing is more easy than to account for the superstitious dread which the Indian felt for the place, holding the Lake for the abode of the Great Spirit, and that one might not look upon its waters without suffering death for his impiety. The superstitions of the white man, too, have often been aroused, and herders and hunters who have been here alone tell strange stories of the phantoms, or water-sprites, or monsters of the deep that they have sometimes seen.

After one's first emotions have been calmed, however, one is likely to feel a little disappointment at the appearance of the Lake. It does not seem so great a distance from the top of the rim down to the water as one had expected; and the walls of the Lake at the opposite end seem of only ordinary height. But the disappointment is only temporary. One may not appreciate the proportions of the Lake at first; but, however long one stays, they steadily grow upon one. It is only when, for example, one tries to distinguish a person standing at the shore of the Lake, and finds him a mere speck in size, or, still better, when one attempts to descend to the water's edge, that one comes to realize the immense depth of the rim. The perspective in that clear atmosphere is very deceiving: an early party of explorers mistook for beaver in the Lake, what they afterward found to be floating logs.

One of the best general views of Crater Lake is obtained from Victor Rock, just below the edge of that part of the rim which one first approaches. As more fully described elsewhere, the Lake is elliptical in shape, 6¼ miles long by 4¼ miles broad, and about twenty miles in circumference. Its contour is broken by only a few moderately indented coves. A comparison of the picture of a model of the Lake (Plate 22) with a picture of the great crater on the moon, shows a striking general similarity between the two. The surface of the Lake is 6,239 feet above sea level; and the rim, varying

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SOUTHERN SHORE OF CRATER LAKE, SEEN FROM VICTOR ROCK.

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in height from 520 feet, its lowest spot, at the Wineglass at the northeast portion of the rim, to 1,989 feet, the highest point above the water, at Vidae Cliff at the south end, is in general undulating, but rising into occasional strongly marked eminences. The slope of the rim is in many places composed of a sheer precipice or of impassable ledges; while in others it has broken away into a talus-slope having an angle of about 40°, easy to descend, but almost impossible to climb again. Beneath the surface of the water the same deep slope continues indefinitely; and in only two places, at Eagle Cove and Cleetwood Cove, is there anything approaching a beach. At the lowest parts of the rim at the north end of the Lake, there are several places where good trails could easily be made to the water's edge, passable even for animals. But at the end nearest the road the only really feasible place to descend and return is at Eagle Cove. The descent can be accomplished here without especial difficulty, and without danger, if caution be observed, in from twenty minutes to half an hour; and the return in double that time.

Unquestionably what is at first, and what remains, the most striking feature of the Lake, is the water itself, in its colors, clearness and reflections. The color of the water at the center of the Lake is a deep ultramarine, far deeper than the blue of the sky at the zenith, even on the clearest day, and—to employ a homely comparison—strikingly suggesting the bluing water in a wash-tub. When reproduced in paintings of the Lake, it is regarded as absolutely incredible by those who have not seen the original. From this intense blue, the color shades off insensibly toward the edges into a turquoise, and, in the few shallow places, into a remarkable, transparent vitreous green. The clearness of the water is as remarkable as the color. One can see the bottom distinctly at a depth of more than 100 feet, and when one looks over a boat's edge down into it, it seems as if one hung suspended between heaven and earth. Despite the height of the walls, the mountain winds sometimes lash the water into waves in which no ordinary boat could live; but when, as usually, the water is calm, the reflection of the walls or of Wizard Island are magnificent. The whole Lake is a perfect mirror; and when one looks from the summit of the Island on a still day, upon

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mile after mile, about the edge of the Lake, of the towering walls and their duplicate reflections, so perfect in every smallest detail that one cannot detect the dividing line between them, the scene is one of indescribable beauty, and haunts one with a fascination from which it is difficult to escape.

It is from Wizard Island, or from a boat, that one can see the reflections to best advantage, and can best appreciate the height of the rim. The distance from the usual boat landing at Eagle Cove to Wizard Island is about two miles; and the trip is one which should on no consideration be omitted. The lower part of the Island is an extremely rough lava field, thinly forested, while the upper part is a yielding slope of broken pumice, through which climbing is quite slow and fatiguing; but the ascent of 845 feet to the top can be made in half or three quarters of an hour by following a well beaten spiral path through the pumice. The top of the Island reveals a most interesting crater, known as the Witches' Cauldron, about 80 feet deep and 475 feet in diameter. In this crater snow drifts lie all summer long. Not the least interesting part of the Island is the low-lying part nearest the shore, with its small but deep inclosed lakes. Looking from the summit of the Island, one's attention is strongly attracted by Llao Rock on the neighboring shore, towering 1,100 feet above the top of the Island, from whose crest Indian legend relates that the Llao, supernatural guardian of the place, flung the presumptuous mortals who dared profane the sacred precincts by their presence. Llao Rock, although only 1,909 feet above the surface of the Lake, reminds one strongly in its upper half, of Yosemite's El Capitan, so much higher; and in its terraced lower half it reminds one no less strongly of the walls of the Grand Canyon. The finest view of it is had from the edge of the rim on the north side of the depression between it and Glacier Peak. Directly opposite the Island, the Devil's Backbone, so interesting to the geologist, is plainly seen, and further to the south Glacier Peak and the Watchman rise nearly as high, though by no means so impressive, as Llao Rock itself.

Looking eastward from the camp-ground at the end of the road, Castle Crest offers a continual challenge to the climber. The climb

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LOOKING EAST FROM BELOW CASTLE CREST.

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THE PHANTOM SHIP.

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is not particularly difficult, and one who will take it, keeping close to the edge all the way, will be richly repaid by many fine views, both of the nearer part of the Lake and the striking faces of Vidae and Dutton Cliffs, and of the country lying in the other direction; for one can clearly distinguish Klamath Lake and the plains about it, with Mount Shasta beyond, Mount Pitt farther to the right, and Union Peak in the near foreground. Beyond Castle Crest, Vidae Cliff and Dutton Cliff form striking eminences which afford extended views in many directions, the latter isolated between two deep and seemingly impassable canyons, whose U-shape proves their glacial origin. At the foot of Dutton Cliff, about fifty yards from the shore, there is to be seen one of the most striking features about the Lake. It is a solitary rock, with sharp, pinnacled top, about 100 feet high, and twice as long and broad. It suggests to the imagination a ship riding at anchor; and its shape, together with the fact that, when viewed from the opposite side of the Lake, against the background of Dutton Cliff, it alternately disappears and becomes visible again, according as it is in sunlight or in shadow, has caused it to bear the name of Phantom Ship. Other features worthy of more than passing attention as one makes the circuit of the Lake are Sentinel Rock, Red Cloud Cliff, with its brilliant pinnacles of reddish tuff near the summit, Grotto Cove with its two grottoes at the water-level, the Wineglass, a slide of a light color reaching from the top to the bottom of the rim, whose shape is distinctly visible from the other side of the Lake six miles away, and the Palisades more striking than those on the Hudson. To appreciate and enjoy these several features of Crater Lake adequately, one should spend a day or two in making the circuit of the Lake by boat, examining each point at leisure.

Another tour of the Lake which will reveal many interesting features not otherwise to be seen, objects of both scenic and scientific interest, is to make the circuit by land. Starting from the usual camp-ground near Eagle Cove, one may proceed with pack animals all the way around to the starting point without especial difficulty anywhere except in crossing Sun and Sand Creek Canyons, but these are so very interesting in themselves as to repay one for any difficulties experienced. There is no road or trail, but the ac-

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companying map will show a feasible route followed by Mr. J. S. Diller of the United States Geological Survey, and the available camping places on it. Mr. Diller furnishes the following description of the route and camps:

"Camp 2, on the west fork of Sand Creek, is a good one with plenty of water and pasture. It is somewhat difficult crossing the canyon of Sun Creek, especially on the west side. It must be crossed just above the end of the small fork. The map indicates approximately the line followed by my pack-train; but there is no trail to mark the way. Camp 3 has many attractions besides the good pasture, fine water, flowers and firs. The great cliffs to the westward are inspiring, and the rustling of the numerous little cascades gives a life to the inclosed camp that is not to be found elsewhere about the Lake. I did not notice any good camping place in Sun Creek Canyon.

The ascent of the east side of Sand Creek Canyon is steep and somewhat difficult, but we got up all right; then we followed the crest to Camp 4, where there is some pasture and snow-water. Beneath the large cliffs below the camp we got water for the animals. To the northeastward about three miles, in the line of the canyon heading over Red Cloud Cliff, we found a large spring and stream not noted on the original map. It is the south fork of Bear Creek, and has a fine cascade a short distance below the spring. There is plenty of water and considerable pasture there, but on the whole it is not as inviting a place to camp as at Camp 4, near the rim of the Lake.

At the foot of Red Cone there is a good camp, Camp 5, near the spring afforded by the melting snow. At many points along the lower slope of the western rim of the Lake there are fine camps, plenty of grass, wood and water; but the sheep have run over it and will soon ruin it unless protected. The trail on the map is not an easy one. For an easy passage between Camps 5 and 6, it is best to keep well down, so as to get below the big cliffs."

A most interesting trip around the Lake by the route above described may be accomplished without difficulty in four days as follows: first night camp at Camp 3; second day ascend Mount Scott, 9,122 feet high (which is not at all difficult and affords a fine view, well repaying the trouble of climbing), descending to Camp 4; third day ascend Llao Rock, and camp at Camp 5; fourth day ascend Red Cone (about 1,000 feet high and easily climbed, similar to Wizard Island, and possessing a crater at the summit about seventy feet deep), and return to starting point, ascending Glacier Peak and the Watchman on the way, if desired. Those who are so inclined may easily find other attractive excursions in the vicinity of the Lake. A two or three days' trip could be taken to Mount Thielsen, sometimes called "the lightning-rod of the Cascades," which is steep and difficult enough to climb to challenge the skill of the mountaineer. It is

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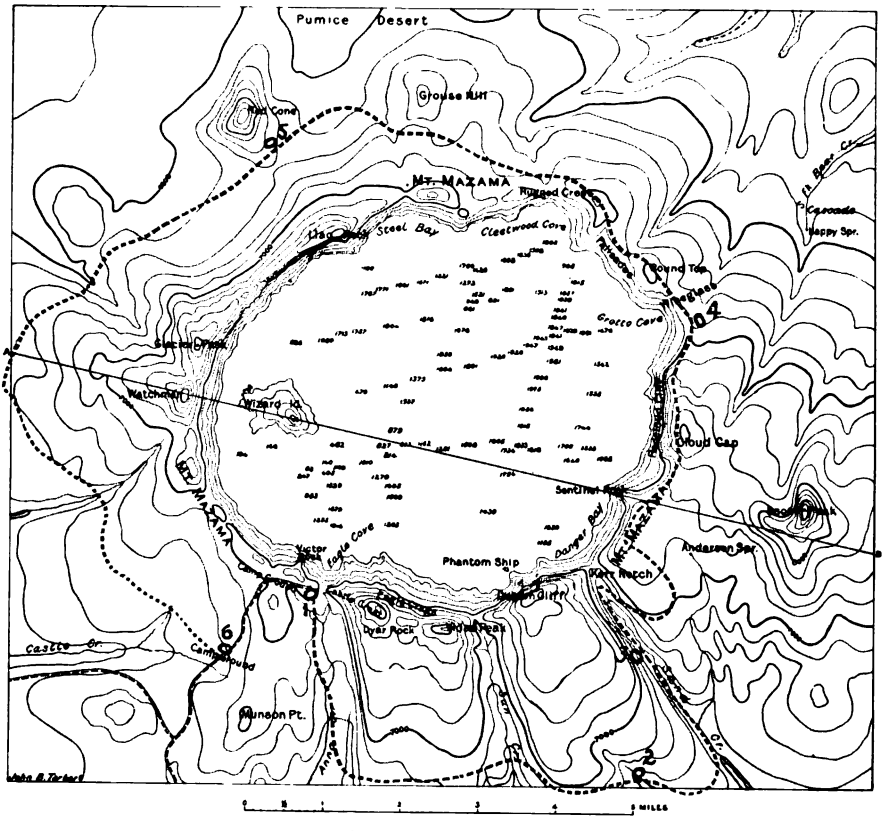

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MAP OF CRATER LAKE
(Soundings in feet).

Trail around the Lake shown thus ----------

Camping places shown thus o

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one of the most interesting peaks of the Cascade Range, and on its very sharp summit, 9,258 feet high, which has been much shattered by lightning, there is found fulgurite, a rock-glass produced by lightning. The mountain is accessible only from the southwest. At Diamond Lake near its foot there is excellent fishing, and good camping ground. There is also said to be an abundance of deer and other game on the east of Crater Lake. Timber Crater, five miles to the north of the Lake, is, like Red Cone and Wizard Island, an excellent example of an extinct cinder cone, and as such, worth visiting. Union Peak, 7,881 feet high, about seven miles southwest of the Lake, is interesting as the remaining core of a volcano once much larger and higher than at present. A parapet of stone piled about its flat top, which is nearly circular and about 12 feet in diameter, indicates that it was once used as a watch-tower by the Indians. To make a trip down along the bottom of Anna Creek Canyon would prove an interesting experience, even if perhaps somewhat dangerous, and would reward the photographer with some unusual views.

But to make Crater Lake more popular as a resort for tourists and other visitors, much must yet be done to make it more easy to go there and more comfortable to stay. If it had the improved turnpikes, the easy stages, and the comfortable hotels which have made it easy for visitors to enjoy the grandeur of the Yosemite Valley without great fatigue or discomfort, Crater Lake would gradually and rapidly become recognized as Yosemite's great rival on the Pacific Coast. When the routes of approach have been improved, when a plain but comfortable hotel has been built, when an elevator has been constructed so that one may descend to the water without great exertion, and when a steam launch has been placed on the Lake, the four things will have been done which must be done before Crater Lake can expect to be visited by any considerable number of people from a distance. Perhaps the first step in this direction would be to have the Lake and its vicinity set aside as a National Park. Efforts looking in this direction were made in January, 1886, when ten townships, numbered 27, 28, 29, 30, and 31, in ranges 5 and 6, were withdrawn from public sale and entry, making a tract thirty miles by twelve. This tract has since been included in the

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Cascade Range Forest Reserve, and the movement for a Crater Lake National Park has languished.* The boundaries ought to be increased so as to include Mount Thielsen, Diamond Lake, Union Peak, and the larger part of Anna Creek Canyon, and the whole permanently set aside as a National Park and place of resort and pleasure for the whole people. When that is done, and the government builds roads within the boundaries of the Park, so as to make all its points of interest easily accessible, and when guarantees are thus secured against vandalism or a mercenary use of the Park, Crater Lake and its interesting vicinity will have received that public recognition which so wonderful a piece of natural scenery richly deserves, and the way will be opened for the enjoyment of it by a much larger number of people than at present.

Portland, Oregon.

* See the article, "Crater Lake, a Proposed National Park," by Capt. C. E. Dutton, in *Science*, vol. vii., p. 179, 1886.

† NOTE: Persons contemplating a trip to Crater Lake, and desiring to secure conveyances, camping outfits or cooks at Medford, Ashland or Klamath Falls, would do well to correspond in advance with the Secretary of the Crater Lake Club at either place.

The Discovery and Early History of Crater Lake.*

M. W. GORMAN.

In company with most places of note, or natural wonders which subsequently become famous, Crater Lake has many claimants to its discovery, and like many of them it has no doubt been re-discovered (if I may be allowed the term) by parties totally unaware of the fact that it had previously been visited or its unique wonders known. That its existence was well known to the Klamath, Modoc and Rogue river tribes for centuries there can be no doubt, but like

* In the correspondence incident to the preparation of this article, many of the letters received have such a permanent value in connection with the early pioneer history of the southern section of the State, that it has been decided to file them in the archives of the society so that they may be accessible for future reference at any time.

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many of nature's wonders, in the early history of even the white races, its unequalled attractions to the student and lover of nature only served to make it in the mind of the untutored savage, the abode of evil spirits (in Klamath *Sko'ks* or *Sku'ks*) and the special domain of an insatiable demon or giant who under the native name of *Llao* or *Lewa*, was ever on the watch to seize upon and annihilate the unwary hunter or presuming brave who should dare to peep over its steep cliffs or look upon its lonely island crater, of which he was the undisputed ruler. In the interest of civilization it is much to be regretted that this legendary spirit does not still hold sway on the island, so that he might smite into everlasting nothingness the despicable mortals who have ruthlessly set fire to and destroyed so many of the noble firs and pines which have so bravely struggled for centuries to maintain the precarious footing they have secured on its arid and uninviting slopes. These stories in course of time became so distorted, and the dangers of a visit to it so exaggerated, that, although well known to them in legend, none of those living at the advent of white men in Southern Oregon, except the *Kiuks* or conjurers of the tribe, had ever seen it, nor could they be prevailed upon to visit it any more than a Klickitat brave of those days could be induced to visit Chitwood (*Gohabedikt*) Lake, or a Shoshone to tempt fate by risking his life in a trip among the legendary spirits who were supposed to hold high carnival about the natural wonders of the Yellowstone valley. The name by which the Lake was known to the Klamaths and Modocs was *Gay-was E-ush*, or *Giwash E-ush*, from *gi*, to be or to stay, *wash*, excavation, and *E-ush*, lake. The name given to it by the Walamswash or Rogue river Indians, I have been unable to learn, though there is ample evidence that it was known to them as well as to the Klamaths and Modocs.

There have been many claimants for the honor of being the first discoverer of Crater Lake, some of them even going so far as to give a detailed account of their trip and claiming to have discovered the Lake in January or February, 1847, while accompanying the late General John C. Fremont in an expedition to California in that year; but on investigation none of these accounts have as yet been authentically substantiated. Having carefully read all of General Fremont's reports so far as published, and knowing his accuracy of

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observation, his impressionable nature, and his rare descriptive powers, I judge it highly improbable that such a marvelous natural wonder could by any possibility have been seen by him and remain unnoted and undescribed, even amid the pressure and excitement of those epoch-making days in the history of the Pacific Coast. In order that credit may be given to whom credit is due, a correspondence has been instituted to ascertain what reliability, if any, should be placed in this claim. Up to date, however, although numerous replies have been received, including one from Mrs. Jessie Benton Fremont, no proof whatever has come to hand in favor of such claim except the fact that on examination of some early files of southern Oregon papers the Lake is found to be referred to as the "Great Sunken Lake" and "Hole in the Ground," the former name being the one applied to it by General Fremont and the latter by the soldiers of the party, according to the story of this claimant.

On the other hand it is quite possible that some eager prospector in search of the "lost cabin mine" or other equally fabulous and elusive mineral wealth, or some adventurous hunter in quest of large game, may have gazed upon its deep ultramarine blue waters and passed on, as he was not looking for "sunken lakes," and only recounted his trip later on when the Lake had been made known to fame by the visits and description of those who appreciated beautiful scenery; just as a young U. S. army officer who visited the now famous Glacier Bay, Alaska, in 1877, in quest of Mountain Goats, passed its grand scenery and unrivalled glaciers by, leaving them to be made known to the world by a genuine explorer two years later.

The earliest discovery of the Lake of which there is any authentic record was on June 12, 1853, by a party of prospectors named —— Dodd, John W. Hillman, James L. Loudon, Patrick McManus, George Ross and Isaac Skeeters, who, in company with some others, had been lured up the Rogue river valley in search of fabulously rich mines reported by some California gold hunters to be on the upper Rogue river.* The events leading up to the discovery were as follows: In the early spring of that year a party of California prospectors came to Jacksonville, and by the secrecy observed in

* The myth of the "lost cabin mine" originated in northern California in the fall of 1850.

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securing provisions and the caution maintained in all their movements, so excited the curiosity of several Oregon prospectors that a party was at once formed and a watch set upon the movements of the Californians which resulted in the leaking out of the old story of "lost diggings" teeming with placer gold, which the newcomers were in search of. As soon as both parties could be equipped a forced march began, and although every device known to the pioneers of those early days was resorted to, the Oregonians could not be misled or shaken off. This state of affairs ceased only on the provisions of both becoming exhausted, when a truce was called and Hillman, the leader of the Oregonians, candidly informed the Californian leader that his party proposed to stay as long as the others were in the mountains. The result was a union of the two parties, the interchange of the secret landmarks and a decision to have a few of the hardier members continue the search and report progress to the main party left in camp. This was accordingly done, and the above named members of the united party were sent forward; but the "lost diggings" did not materialize, and game being scarce it soon became a serious question how longer to maintain even this small party in condition to continue the search for the famous diggings. To make matters worse the party had lost nearly all idea of their whereabouts and had to resort to the old method of climbing peaks to ascertain them. From the summit of one of these peaks they saw numerous lakes, and finally after ascending a long gentle slope they came upon the brink of a precipice where far below them lay, what the leader of the party describes as "the bluest lake I ever saw." Their hunger was for the time forgotten as they gazed at its placid blue waters and in the clear atmosphere of that season of the year realized its great expanse. They reached the rim at a point a little west of Victor Rock, found the snow reaching down to the water in very many places, and, continuing along the rim for some hours, they estimated the Lake to be not less than 20 miles in diameter, and judged its distance from Jacksonville to be about 125 miles. They looked in vain for an outlet, which made their discovery seem all the more wonderful, and they saw, and on their return gave a fairly accurate description of Wizard Island, but failed to notice the Phantom Ship. After their wonder and excitement had subsided,

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the naming of the Lake was discussed and, each one suggesting a name, it finally narrowed to the selection of one of two—Mysterious, or Deep Blue Lake—the latter being given the preference, though it was occasionally referred to afterwards as Lake Mystery. One member of the party suggested their making the descent to the water, but this was at once frowned down by his companions, who in their half-famished condition were more intent upon securing game with which to satisfy the cravings of hunger than in exploring beautiful scenery. The party soon proceeded on its way and on returning to civilization reported its wonderful discovery, but there being no newspaper then published in southern Oregon (the first number of the *Oregon Sentinel* was issued on January 13, 1855), no account of it was printed, and in the stirring events of those days, when slaying Indians and searching for gold were the two chief occupations of the early settlers, it soon came to be looked upon as a miner's tale, and in course of time was forgotten. It is characteristic of the endurance, intrepidity and physical stamina of those early pioneers that although 44 years have since elapsed, three of the above mentioned party of six, viz,:—Hillman, Ross and Skeeters, are still living, notwithstanding that the first named was severely wounded in an engagement with the Indians shortly after returning to the settlements.

Nothing further was heard of the Lake until the fall of 1862, when it was again discovered by a party of six miners returning to the Rogue river valley for the winter from the Granite Creek mines on the North Fork of the John Day river. On the afternoon of Tuesday, the 21st of October of that year, these men, Hiram Abbott, Joseph Bowers, (one account gives this name as J. Brandlin) James Layman, Chauncy Nye, John W. Sessions and S. H. Smith, had been traveling all day, and in searching for water for a good camping place in the evening suddenly came upon the Lake. It was only after seeking in vain for a place to make the descent to the water, and rolling down some large rocks to its surface, that they fully realized the height of the rim, and abandoning the attempt to obtain water from this source concluded to melt snow for the purpose. As the fall was a mild one, there was no fresh snow above the rim, but they found the old snow still lying in patches two to

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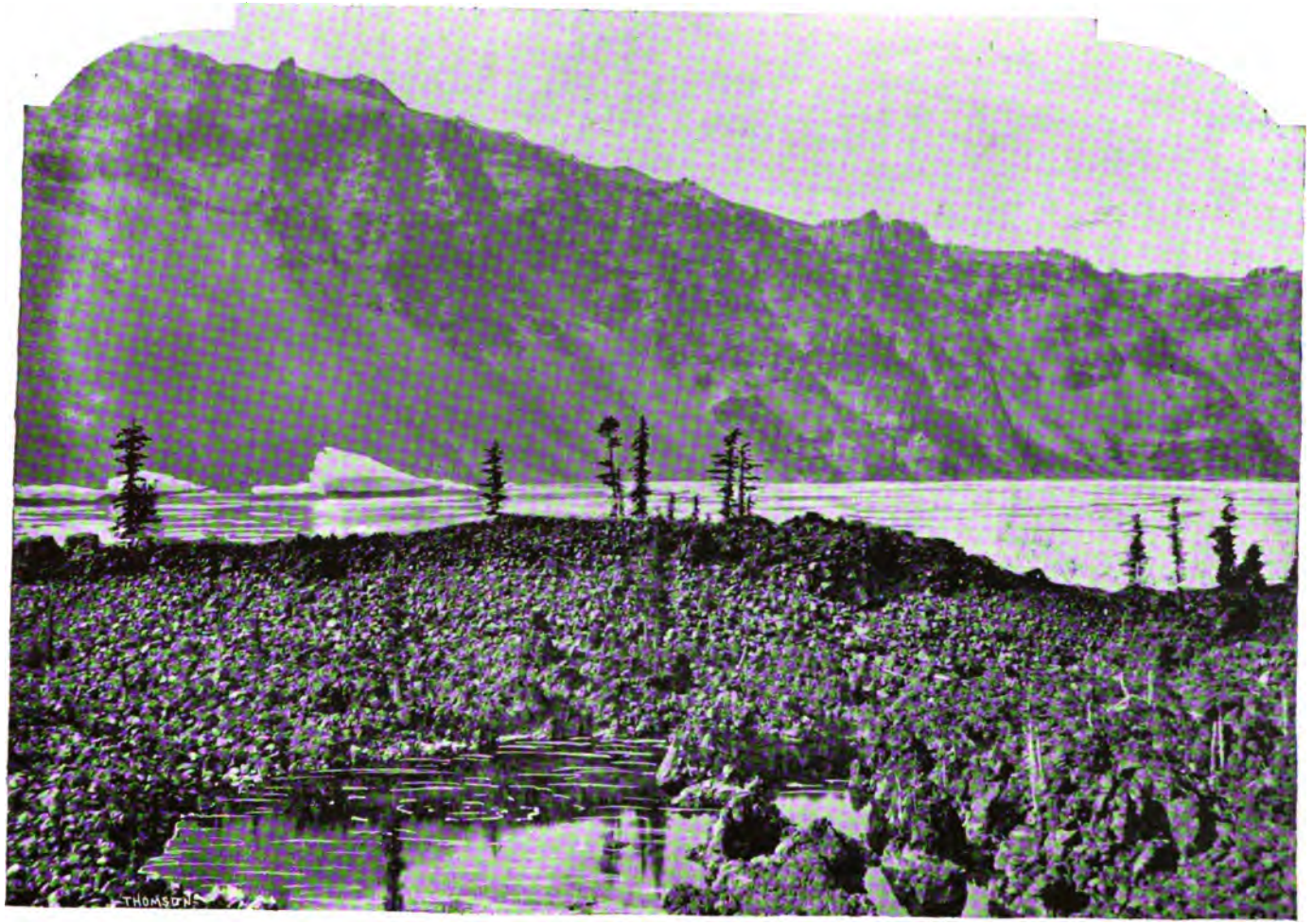

Photo. by H. B. Patton.

SOUTHWEST SHORE OF CRATER LAKE, LOOKING FROM WIZARD ISLAND.

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three feet deep, and drifts of snow lay clinging to the crevices of the rocky bank below the rim. They further reported bunch grass as being abundant and of good quality, and but little timber at the point at which they reached the Lake. They estimated the Lake to be not less than twenty-five miles in circumference, and the rim at that point to be about 3,000 feet above the surface of the water. This was the first party that even approximately located the Lake, as the Hillman party were too exhausted and bewildered when they discovered it to be able to give any very accurate account of its location on their return to the settlements. This party named their discovery Blue Lake, their chief contribution to its fame being the authentication of its existence and defining its location. A description of this trip was published in the *Oregon Sentinel* for November 8, 1862; and this, so far as I have been able to learn, is the first printed account of the discovery of the Lake.

As the topography of the region was wholly unknown at that early date, the party thought it necessary to climb a peak or eminence of some kind every few days to take observations, as they were somewhat afraid of getting on to the head waters of the Umpqua instead of the Rogue river. In doing this they observed a prominent conical rocky peak, which they decided to ascend for the above purpose. Only four of them succeeded in reaching the summit, which they found to be about twelve feet across, nearly circular, flat and with a parapet of loose rocks piled about its outer edge, indicating that it had been used as a lookout or watchtower by the Indians. As the country was then in the throes of civil war, and partisanship ran as high on the Rogue river as on the Rappahannock or Rapidan, the peak was unanimously named Union Peak, as all four were ardent Union men.

Three years later the Lake was again discovered by a party to whom its existence was previously unknown. In July, 1865, Capt. F. B. Sprague, of Company I, 1st Oregon Infantry, undertook to complete a road from Union Creek to Fort Klamath; and in carrying out this object two of the men, John M. Corbell and F. M. Smith, while out hunting about August 1, accidentally came upon the Lake; and on returning to camp, and reporting their wonderful discovery, so excited the curiosity of the party, that it was decided to

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visit and explore the Lake at the first opportunity. In the meantime, one of the then periodically recurring Indian troubles broke out, and a detachment of volunteers from this party was sent to the Stein's Mountain country to operate against the Snake Indians. While on the way six members of this detachment—William Bybee, James Cluggage, J. B. Coats, Peyton Foote, Franklin B. Sprague and Orson A. Stearns visited the Lake on August 24. All except Cluggage made the descent to the water, and at the suggestion of Capt. Sprague they decided to christen the Lake. As Mr. Stearns was the first to reach the water this honor devolved upon him; and he thereupon, with appropriate ceremonies, named it Lake Majesty. They reached the rim almost at the same locality where it is reached by the present wagon road, and made the descent a little to the north of this point. They reported having seen a kingfisher near the water's edge, and from this inferred that there were fish in the Lake; an inference that has so far never been verified. This was the first party that actually reached the waters of the Lake, and the first to observe and report the Phantom Ship. An account of this trip and the christening of the Lake, written by Capt. Sprague on August 25, appeared in the *Oregon Sentinel* for September 9, 1865.

Shortly after this a party of eleven, viz.: John Bilger, J. B. Coats, Isaac Constant, T. Constant, James D. Fay, Herman Helms, —— Kibbert, James Layman, John Neuber, W. A. Owen and T. Willitt, under the leadership of James D. Fay, while on a hunting trip to Diamond Peak, arrived at the Lake on September 3, 1865, striking it on the side nearest Wizard Island, where Fay and Helms made the descent to the water, and inscribed their names with the date on a rock at the water's edge. The striking appearance of Wizard Island with its partially wooded slopes and crater-like top, so appealed to their imagination that they thereupon formed the determination to visit the Lake again and bring a boat with which to reach and explore the Island. In the 32 years which have since elapsed nine of this party have joined the "great majority," and only Messrs. Helms and Owen survive to tell of their early journey to the "Great Sunken Lake," as it is termed in a southern Oregon paper of that year.

In the course of time the numerous reports that had reached the

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WIZARD ISLAND FROM THE WATCHMAN.

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settlements regarding the "Great Sunken Lake" and its lonely island crater on which the foot of man had never trod, had so excited that love of adventure and exploration which is ever present in the colonizing and energetic races, and particularly in evidence in frontier life, that in July, 1869, a party was formed in Jacksonville consisting of J. B. Coats, James D. Fay, Miss Annie Fay, David Linn and family, Miss Fannie Ralls, James M. Sutton and family, and John Sutton, under the leadership of James M. Sutton. They left Jacksonville on July 27, *via* the Rogue river road, and on reaching its junction with the road to Fort Klamath, blazed and opened a wagon road to the rim of the Lake, where they were joined by Col. J. E. Ross, Lieut. S. B. Thoburn and Mr. Ish. They had brought with them a wooden boat, knocked-down, which they put together at the Lake, and with infinite labor and care to protect it from the rocks, they succeeded in lowering it to the water; and on August 4, in this frail craft J. B. Coats, James D. Fay, David Linn, James M. Sutton and Lieut S. B. Thoburn visited Wizard Island, which was, with appropriate ceremonies, so christened by James M. Sutton. They were thus the first human beings to set foot on its virgin soil, and climbing its steep slopes they entered the tiny crater, which is such a duplicate in miniature of the great caldera which contains the Lake itself. A record of the trip was enclosed in a tin can and cached in the rocks at the top of the old crater rim on the Island. They brought the first wagons to the Lake, Mr. Linn's wagon hauling the boat which they left at the Lake on their departure. They attempted to circumnavigate and sound the Lake, but their boat proved too frail a craft for this purpose; they succeeded, however, in taking one effective sounding 550 feet deep, half a mile from the Island, and from the slope estimated the Lake to be from 1,500 to 2,000 feet in the deepest part, an estimate which recent measurements have shown to be fairly correct. They were the first party to name it "Crater Lake," and having brought a camera with them were the first to secure pictures of the Lake and of the most picturesque pieces of scenery on the way. A specimen of these early triumphs of the photographic art would now be a treasure, but I have so far been unable to secure one. They left the Lake on August 5, returning

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to Jacksonville by the Rogue river road, and visiting Fort Klamath and other points of interest on the way, besides securing with considerable difficulty a picture of Rogue river falls. They reported that they "had much dust during the day and the air was loaded with smoke," a piece of evidence which the Mazama party of August, 1896, can fully corroborate. A graphic account of this trip was published in the *Oregon Sentinel* for August 21 and 28, 1869, in which the name "Crater Lake" appears in print for the first time.

From this time on, the Lake gradually became known to fame; and in August, 1872, it was visited by Lord William Maxwell of Kirkcudbrightshire, Scotland, and Mr. A. Bentley, of Toledo, Ohio, who, accompanied by Capt. O. C. Applegate, John Meacham and Chester M. Sawtelle, of Klamath County, succeeded in placing a boat upon its waters, and were the first party to make an extended trip over its surface and view the picturesque peaks of its lofty rim from the best vantage points on the waters of the Lake itself. They visited Wizard Island, found the record left by the Sutton party in 1869, and, after skirting the borders of the Lake, named some of the more prominent peaks after members of the party. Among some of the names given were Bentley Peak, to what is now known as the Watchman, and sometimes called Helio Peak, Maxwell Peak to what is named Glacier Peak on the present map and Shag Rock on the Ashland sheet of the United States Geological Survey, and Applegate Peak to the present Vidae Cliff.

The first Geological Survey party to visit the Lake was in 1883, when professors J. S. Diller and Everett Hayden spent several days in examining the rocks composing the rim, and, making a raft of logs, paddled out to and explored Wizard Island.

The attention of the federal government having been called to the matter in 1885, a party from the Geological Survey under the direction of Captain (now Major) C. E. Dutton, was detailed to survey and sound the Lake, which task they performed in a thorough and efficient manner between July 11 and August 5, making in all 168 soundings, ranging in depth from 93 feet in the shallowest to 2,008 feet in the deepest part sounded. A short account of the work accomplished may be found in *Science*, vol. vii., 1886, p. 179,

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and in the Eighth Annual Report of the United States Geological Survey, Part I., p. 156. At the same time the topographic details of the work were carefully carried out by Messrs. Mark B. Kerr and Eugene Ricksecker, the whole resulting in the present excellent map of Crater Lake, which is issued as a detail of the Ashland sheet by the United States Geological Survey.

The more noticeable and important points of interest about the Lake and rim were at the same time named as follows: The Watchman to the first peak west of the upper camping ground; Glacier Peak to the next, from a rock there showing the striations made by an ancient glacier; Llao Rock, after the giant or spirit which legend says formerly held sway there (this was formerly known as Mount Jackson in honor of Maj. James Jackson, U. S. A.); Palisades to a section of the northeast part of the rim, from its fancied resemblance to the Palisades on the Hudson; Red Cloud Cliff to a section of the rim due east of Wizard Island, from the red color of the rocks composing it; Sentinel Rock to a prominent rock a little farther south; Kerr Notch to a dip in the rim at the head of Sand Creek, in honor of Mr. Mark B. Kerr; Dutton Cliff in honor of Capt. C. E. Dutton; Vidae Cliff in honor of a young lady of Portland; Eagle Crags, to a series of jagged rocks on the south side of the rim; Cathedral Rock, from its fancied resemblance to the spires of a cathedral (this has since been changed to Castle Crest); Prospect Rock, to a prominent rock on the edge of the rim opposite the upper camping ground, from which one of the best views of the Lake can be obtained (this is now called Victor Rock, in honor of Mrs. Frances Fuller Victor); Eagle Cove, to a small bay where the present trail leads from the rim to the water; Steel Bay, to a bay just east of Llao Rock, in honor of Mr. W. G. Steel; Cleetwood Cove, after the name of the boat used by the survey party; Grotto Cove, after some caves found near the water's edge in the rim at that point; Phantom Ship, to a prominent rock jutting out of the water under Dutton Cliff, and marking the continuation of an arete which is to be seen on the side of the cliff at that point. The past year the name Rugged Crest has been given to the section of the rim overlooking Cleetwood Cove; and on August 21, the name Mount Mazama was, with appropriate ceremonies, given to the mountain containing the

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Lake itself. These names, with the exception of the recent additions, have all been confirmed by the United States Board on Geographic Names.

In compliance with a petition forwarded to Washington in 1885, and ably advocated by Congressman Binger Hermann, the Secretary of the Interior, L. Q. C. Lamar, recommended the "temporary withdrawal of certain public lands in Oregon pending legislation, looking to the creation of a public park which shall embrace Crater Lake." On February 1, 1886, President Cleveland signed an executive order withdrawing from settlement or sale ten townships surrounding and including Crater Lake, viz.: Townships 27, 28, 29, 30 and 31, in ranges each 5 and 6 east, Willamette meridian.

In June, 1892, the Oregon Alpine Club sent to Washington a petition asking for the creation of a Forest Reserve along the Cascade Range in Oregon, in accordance with the Act of March 3, 1891, authorizing the President to set aside public lands as forest reserves; and on September 28, 1893, President Cleveland issued a proclamation creating the Cascade Range Forest Reserve, which includes within its southern limits Crater Lake and its environs.

Portland, Oregon, April, 1897.

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VIEW ACROSS WESTERN PART OF CRATER LAKE.

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RIM OF CRATER LAKE (MOUNT MAZAMA) IN THE DISTANCE, LOOKING NORTH ACROSS ANNA CREEK CANYON.

Photo. by J. S. Diller. By permission of National Geographic Magazine.

SOUTH SHORE OF CRATER LAKE, LOOKING WEST FROM KERR NOTCH, SHOWING DUTTON CLIFF (LEFT), PHANTOM SHIP (CENTER), AND CASTLE CREST (RIGHT).

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The Geology of Crater Lake.*

J. S. DILLER.

The crater lakes Bolsena and Bracciana in Italy, Paven in France, and Laach in Germany, besides numerous other examples in various parts of Europe, South and Central America, and Asia, have long been known to science; but the one in the United States which, all things considered, is the most imposing of the series, has scarcely been mentioned in scientific publications, and its very existence even appears to be generally unknown to persons interested in such features.

The Crater Lake of Southern Oregon is deeply set in the summit of the Cascade Range, and is remarkable not only for its geological history, of which it contains some especially interesting chapters, but also on account of its geographic position and depth, its beautiful blue transparent waters, and the grandeur of its completely encircling cliffs affording no outlet.

The summit of the range at this point is broad, with gentle, canyoned slopes surmounted by numerous volcanic cones. The rim of the Lake, which is nearly circular, with an average diameter of six miles, rises a thousand feet above the level of the range. Its outer slope is gentle and rather regular, from 10° to 15°, but within,

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the descent to the Lake is precipitous. In general the rim may be described as the hollow base of a very large but deeply truncated cone. Here and there, two to four miles from the crest upon the outer side, are cinder and lava cones, adnate to the great central volcano. The crest of the rim varies in height from 6,759 to 8,228 feet above the sea, *i. e.*, 520 to 1,989 feet above the Lake. Its prominences stand at the head of spurs radiating from the Lake. Some of these ridges were formed by single streams of lava, but others result from erosion and are separated by deep canyons, such as those of Sand Creek and Sun Creek, which pass directly through the rim.

The rim is composed wholly of lava streams and beds of volcanic conglomerate, dipping away from the Lake as shown by the accompanying figure. This is the normal composition and structure of the basal portion of a large volcano.

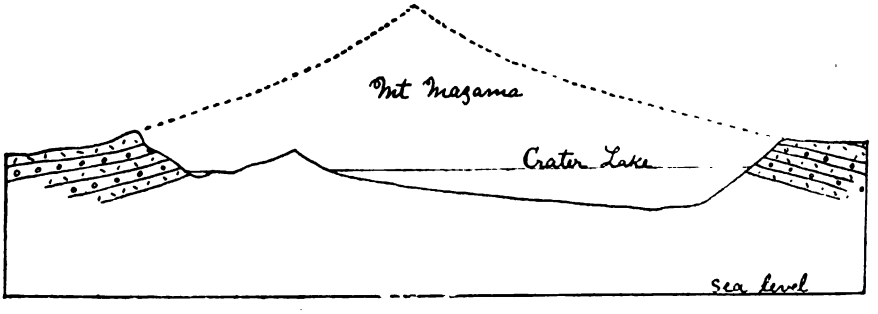

Figure 1. Section of Crater Lake and its rim, with the probable outline of Mount Mazama. Structural details generalized. Vertical and horizontal scales the same.

The southern and western parts of the rim are made up of many beds; those of lava generally predominate, both in size and in number. The northeastern portion of the rim at the Palisades is made up almost wholly of one great flow. The same is true to a less extent at Llao Rock, which is formed of a short but broad stream over 1,200 feet in thickness. The exposures upon the inner slope of the rim show sections of the lava streams radiating from the Lake, and that of Llao Rock furnishes a good example. Its greatest thickness is in the middle, where it fills an ancient valley down the northwestern slope of the rim, and tapers upon both sides to a thin

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ANNA CREEK CANYON.

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CRATER LAKE, AS IT WOULD APPEAR FROM A HEIGHT OF 20 MILES ABOVE IT. (FROM A RELIEF MODEL.)

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edge as seen in Plate 19. This massive flow rests locally on an irregular layer of pumice, and is overlain by the same sort of material.

Andesites predominate, especially among the earlier lava flows so well exposed in section upon the inner slope of the rim; but rhyolites are common among the later ones, and are usually associated with pumice. Basalts were not observed in the rim. However, they occur upon its outer slope, several miles away from the crest. They are connected with prominent cinder cones adnate to the once greater central peak, and are the newest lavas of the region, excepting that of Wizard Island within the Lake. This succession of lavas has been observed in many large volcanoes and clearly points to Crater Lake as the site of such a mountain.

The rim is intersected by a number of vertical dikes, some of which stand out prominently upon its inner slope. The largest of these, locally known as the Devil's Backbone, varies from five to twenty-five feet in thickness, and cuts the rim from water to crest one and a half miles southwest of Llao Rock. It is shown in Plate 19 over the western base of the cone on Wizard Island. Nearly a dozen other dikes appear in various parts of the rim, and all radiate more or less directly from the Lake. Some of them cut through the older lavas only. Others reach to the top of the rim, but none were seen to penetrate the late flows of rhyolite. The dikes are of andesite, and their radial arrangement, as well as the succession of lavas, points to the middle portion of the Lake as the center from which they emanated.

The name Crater Lake suggests that the Lake occupies a crater, and it would naturally be supposed that the crater was originally as large as the rim of the Lake. That this is not the case, however, is indicated by the following consideration.

No lava came out through the flanks of the rim, excepting the basalts which are associated with cinder cones low on its outer slope. The lava streams generally reach up to the crest and radiate from the rim. If the crater were as large as the rim, the lavas must have escaped by overflow from its lowest point, and the inner slope of the rim would bear traces of the rise and fall of the lava within, instead of exposing sections of all the coulees and sheets of con-

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glomerate of which it is made up. The inner slope of the rim is one of fracture and not of flow, and shows that the lava streams once extended further towards the center of the Lake than now, and were more elevated in that direction. They issued from the crater or sides of a huge volcanic peak, Mount Mazama, which once stood upon the present site of the Lake.

The rim of the Lake has been extensively glaciated, and affords ample evidence concerning a change in the topography of the region since the glacial period. Moraines are widely spread over a large part of the rim, and extend in some cases far beyond it down the principal lines of drainage upon both sides of the range. The glacial debris is occasionally accumulated in well defined ridges transverse to the direction of glacial motion, but more commonly is spread over the region in an irregular veneering composed of boulders, gravel and sand. From the main highway to the Lake is a wagonroad which ascends over a steep slope littered with many boulders and irregular piles of glacial debris. On the east of the road is the crest of the range. Against the rim of the Lake this crest ends in a prominent moraine ridge marking the line of separation between the glacial lobes which descended Anna and Castle Creeks on opposite sides of the range.

At many points on the very crest of the rim, glacial debris is well exposed resting on striated rocks. Occasionally the debris is over 50 feet in thickness, but it is rarely composed of large fragments. The largest boulders, about 10 feet in diameter, were seen some distance from the crest upon the outer side.

Glaciers descended all the valleys upon the outer slope of the rim for from two to five miles. Below, the moraines terminate in plains through which the present streams have cut narrow deep cañyons with columned slopes or cliffs, rendering them inaccessible. Their sculptured walls gave name to Castle Creek, but an equally fine display occurs along Anna Creek.

Glacial striæ are well marked at many points, on the very crest of the rim, radiating down the outer slope in some cases for a distance of five miles. The slopes were so generally covered with moving ice that the outlines of the glaciers were not well marked.

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GLACIATED CREST OF RIM OF CRATER LAKE.

Photo. by H. B. Patton. By permission of National Geographic Magazine.

SNOWDRIFT IN CRATER OF CINDER CONE
ON WIZARD ISLAND.

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Probably the largest mass was that of the Divide Glacier, which had a width of over four miles upon what is now the rim of the Lake. The main portion descended Castle Creek and its branches toward Rogue river, but a large lobe extended down Anna Creek on the eastern slope of the range.

A large mass of ice descended the valley next south of Llao Rock, reaching far down over the broad stream of basalt from Red Cone. The lavas are deeply planed off and striated, but the effect of glacial erosion upon the general topography is not so marked as upon the southern side of the Lake where deep U-shaped canyons have been cut in the older lavas.

That the volcano was active at intervals during the glacial period is well shown by the glaciated flow of Round Top, upon the northeastern edge of the rim. This flow is overlain by two layers of pumice separated by a sheet of rhyolite, all of which were erupted after the glaciation of the surface upon which they rest. The eruption must have been accompanied by great floods from the snow-capped mountain. Such floods would account for the fact that all the valleys radiating from Crater Lake have been extensively filled with sediments.

Reference has already been made to the occurrence of glacial striæ on the very crest of the rim. They may be seen in many places along the crest northwest of Victor Rock; also a few miles beyond in the sag of the rim next southwest of Llao Rock, as well as near its summit. They occur also in Round Top, in Kerr Notch and over Eagle Crags, completing the circuit of the Lake from which they radiate. The topmost rocks of the crest are planed off and well striated upon the outer slope, but not upon the steep broken surfaces which they present to the Lake. Glaciation is a feature of the outer slope only, and it is evident that the ice armed with stones to scratch these rocks must have come from above, that is, from a peak which once stood upon the site of the Lake.

In the deep U-shaped canyons of Sun and Sand Creeks, there is evidence to the same effect. They extend directly through the rim to the brow of the cliff, over 500 feet above the Lake's surface, and belong to a system of drainage which has been completely de-

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capitated. It is impossible to account for the glacial phenomena and drainage features of that region on the supposition that its topography is unchanged.

The succession of lavas and the system of dikes point to a volcanic center within the circle of the rim; but the structure of the rim, the condition of its inner slope, and its glacial phenomena go a step further, and suggest that during the glacial period the Lake did not exist, and that its site was then occupied by a huge volcano which furnished the coulees and sheets of fragmental material in the rim, as well as the masses of ice and snow for its glaciation.

In Figure 1, the probable outline of the peak is indicated. Judging from the character of the lava, the slopes of the rim, its size and the extent of its glaciation, it is reasonable to suppose that Mount Mazama was once a rival of Shasta and Rainier for the supremacy of the range.

The greatest feature of the region is the enormous pit or caldera containing the Lake. It is 4,000 feet deep, extending from the crest of the Cascade Range down half way to the sea level. More than a square mile of its bottom is below the level of Klamath Lake at the eastern base of the range. The pit is half concealed by the Lake which so greatly beautifies the scene.

The volume of the pit is nearly a dozen cubic miles, and if we include the lost peak, it would possibly be half as large again. The problem presented for solution by the removal of such an enormous mass and the development of so great a completely enclosed pit in the process, is one which has not yet been completely solved. There are, however, some phenomena about the Lake that throw considerable light upon it, especially when taken in connection with those of similar features in other parts of the globe.

The composition and structure of the mass removed connects its transfer at once with volcanism, and the form of the remnants renders it necessary to suppose that it was either blown out by a tremendous volcanic explosion or swallowed up by an equally great engulfment.

The occurrence of a distinct rim at once looks favorable to the explosion method, for rims more or less complete made up of the

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ejected materials, are known about many pits formed in that way.* As we have already seen, however, the rim is made up neither wholly nor in any part of fragments blown out of the pit, but, on the contrary, is composed throughout of layers of solid lava alternating with those of volcanic conglomerate and tuff, all of which were erupted from Mount Mazama before the pit originated. There are, indeed, great quantities of pumice in the region, but that is at least in large part clearly associated with the last eruptions of Mount Mazama, for it underlies some of the latest flows, and differs widely from the material (andesite) of which the basal portion of that great volcano was made up. The entire lack about the pit of material corresponding in kind, form or quantity to that which would necessarily arise if the pit were produced by a great explosion, compels us to look in the other direction for the solution of the problem.

While it is true, as shown by Lyell§, Scrope†, Judd‡, Geikie§§, and others that the majority of crater lakes occupy basins produced by volcanic explosions alone, there are others which the same authors recognize as occupying areas a portion of whose depression is attributed to subsidence. Lake Lonar in India has a low rim of fragmental material, but its volume is much less than that of the pit which it surrounds. For this reason the pit is ascribed chiefly to subsidence. Major Dutton‖ has pointed out a number of similar sunken areas or pits, but without lakes, in the Hawaiian Islands, and Dana has described¶ the sinking of the lava column, (molten material), thus deepening the pit, in the yet active volcano of Kilauea. The subsidence of the molten material in the throat of the volcano, and the consequent collapse of the floor of the pit with portions of the surrounding cliffs, are shown to result from the escape of the lava through fissures at much lower levels upon the slope

*Volcanoes: The character of their phenomena, etc., by G. Poulett. Scrope, p. 215.

§Elements of Geology, Sixth Edition, pp. 679-82.

†Volcanoes, The character of their phenomena, etc., by G. Poulett, Scrope, pp. 222-225.

‡Volcanoes, by J. W. Judd, pp. 170-171.

§§Text Book of Geology, Third Edition, p. 240

‖Maj. Dutton, who made a study of Crater Lake, after having visited the great volcanoes of the Hawaiian Islands, came to the conclusion that this depression was "formed in the same manner as the great calderas of the Hawaiian Islands" (U. S. Geol. Survey, Eighth Annual Report, p. 158), that is, "by the dropping of a block of the mountain crust which once covered a reservoir of lava, this reservoir being tapped and drained by eruptions at much lower levels." (U. S. Geol. Survey, Fourth Annual Report, p. 105).

¶Characteristics of Volcanoes (1891), p. 127; and Manual of Geology, Fourth Edition, pp. 284-5.

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of the mountain. In connection with the subsidence of the lava in Kilauea in 1840, a mass was erupted 27 miles from Kilauea and about 2,700 feet below the summit of its cliff. In some cases, however, the sinking of the lava in Kilauea is not known to have been accompanied by an eruption of lava upon the surface.

The view that the caldera of Crater Lake originated by subsidence, appears especially applicable for the reason that it occurs in the summit of a prominent range. The western slope of the range, although not steep, is considerably more inclined than that of Kilauea, and within 15 miles of the Lake, the level of its deepest bed appears upon the surface. The engulfment of Mount Mazama and the production of such an enormous pit in the process, may well be expected to have given rise to eruptions upon the lower slopes of the range at no very great distance from the Lake.

That Mount Mazama actually disappeared by subsidence is plainly suggested by the behavior of the last erupted lava. It is rhyolite which escaped from the north slope of Mount Mazama. Its broad stream follows a shallow valley that now appears in the rim at the head of Cleetwood Cove. Upon the outer slope of the rim opposite the cove, there is a long depression down the surface of the flow where cliffs, columns and angular blocks occur in great confusion. They have resulted from the caving in of the crust of the lava tunnel in the valley filled by the thickest portion of the flow. But on both sides the lava surface is smooth and easily traversed.

Upon the inner slope of the rim is an equally remarkable and exceptional feature. Descending from the Rugged Crest, at the upper end of the broken tunnel, to the Lake, is a flow several hundred yards in width. It is part of the large stream of rhyolite which spread upon the outer slope of the rim, and has flowed inwards towards the Lake over the broken ends of the older coulees of andesite. The fluidal structure, as well as the parting planes produced by it, are well marked approximately parallel to the inner slope of the rim. It is the only inward-flowing lava found any where on the rim, and appears to indicate that before the thickest portion of the final flow of rhyolite had completely solidified, Mount Mazama was engulfed, and the yet viscous lava followed it towards the abyss.

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It might be supposed that a study of the features upon the bottom of the great pit would disclose the character of the change by which it was produced; but this is not the case. Its original surface is in large part, if not wholly, covered by the products of later volcanic eruptions. We have an excellent opportunity to study this portion of the pit on Wizard Island, where the bottom rises above the surface of the water. This island, which is well represented in Plate 19, is formed of a cinder cone and lava field, practically unchanged since their recent eruption. The steep-sloped cinder cone, 845 feet in height, is surmounted by a perfect crater 80 feet in depth. The encircling lava field, made up of angular blocks of dark lava broken up at the time of the eruption, is rough in the extreme.

Judging from Wizard Island, one might expect that there were other piles of recent cinders and lava upon the bottom of the pit, and so it seems; for according to the soundings of the Lake made by Captain (now Major) Dutton in 1886*, there are two such prominences rising from great depths, but failing by several hundred feet to reach the surface of the water. The eruptions of lava and fragmental material upon the bottom of the pit have partially filled it up, but how much has been lost in depth by these final outbursts cannot be estimated.

To epitomise: The history of Crater Lake and its rim began in the upbuilding, by normal volcanic processes, of a large volcano, Mount Mazama, comparable in the nature of its lavas and in its structure and size, with the greater peaks of the Cascade Range.

Crater Lake did not then exist. Its site was occupied by Mount Mazama, which was an active volcano in the glacial period. Glaciers descended from its higher slopes, scratching the rocks and depositing moraines about its base. The later eruptions of Mount Mazama occurred in the glacial period, and doubtless produced extensive floods which filled with debris the valleys of all the streams radiating from the mountain.

In approximate connection with its final eruption, the molten material of the interior withdrawing, the summit of Mount Mazama caved in and sank away, giving rise to a caldera nearly six miles in

* U. S. Geol. Survey, Eighth Annual Report, Part I., pp. 157-8.

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diameter and 4000 feet deep. Thus originated the great pit in which Crater Lake is contained, encircled by a glaciated rim, the hollow base of the engulfed Mount Mazama. Upon the bottom of the caldera, volcanic activity continued. There were new eruptions building up cinder cones and lava fields, and partially refilling the great pit. Precipitation is greater than evaporation in that region. Volcanic activity ceasing, the conditions were favorable for water accumulation, and Crater Lake was formed in the pit.

United States Geological Survey, Washington, D. C.

The August Vegetation of Mount Mazama, Oregon.

FREDERICK V. COVILLE.

While engaged in an investigation of the plains vegetation of southeastern Oregon during the summer of 1896 with Mr. John B. Leiberg, it was my good fortune to receive and be able to accept an invitation from the Mazamas to visit Crater Lake at the time of their annual excursion. We reached the Lake from Fort Klamath by way of Anna Creek and Pole Bridge August 13, a few days in advance of the Mazamas, and remained until the morning of August 20, when we set out on our return to Fort Klamath by the same route. Our camp at the Lake was in a grove of trees near the rim of the crater, a few rods west of the point marked on the map as the "camp ground," and in this article referred to as the "upper camping place." We made collections in the ravine of Pole Bridge Creek; along the road from this point to the camp at Crater Lake; along the rim of the crater as far east as a point midway between Vidae Cliff and Castle Crest, and as far west as the Watchman and Red Cone; down the outer slope of the crater south of the Watchman to the line of springs at its base; down Anna Creek about

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CASTLE CREST AS SEEN FROM VICTOR ROCK.

Photo. by M. M. Hazeltine. By permission of Southern Pacific Co.

WIZARD ISLAND FROM GLACIER PEAK.

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2 kilometers (a mile and a quarter) from camp; down the inner slope of the crater along the trail to the boat-landing; and on Wizard Island.

Besides the vegetation of the forests and the open pumice fields, the places of especial interest botanically were the spring at the head of Anna Creek, where there were many attractive plants in a small wet meadow; Castle Crest and the Watchman, which bore a number of rupestrine plants not found elsewhere; the trail down the inner slope of the crater, which furnished a varied and interesting series of plants; Wizard Island, which with its steep cone of cinders and the lava beds at its base possessed a remarkable collection of the plants of volcanic ashes; and finally the plateau at the outer base of the crater rim 2 or 3 kilometers south of the Watchman. This is a part of the same plateau from which the road to Crater Lake rises after it leaves the lower camping place. The particular locality that we visited is difficult of access, but is best reached by following the rim of the crater northwestward nearly to the foot of the Watchman and then turning southward. Many springs burst out upon this plateau from the base of the crater, making small meadows which support an extremely beautiful and interesting flora.

Mount Scott furnishes little of interest, its vegetation consisting of hardly more than twenty-five species, nearly all of which grow at much more easily accessible places. This peak is not recommended for a botanical excursion. Mr. Elmer I. Applegate, who made a special trip to Mount Scott from Red Cloud Cliff, reports upon its vegetation as follows:

"From base to summit Mount Scott is composed principally of pumice of a loose, sliding character, supporting little vegetation. We found no permanent water, either on the mountain or about it. About the base is an interrupted growth of scrubby timber, extending up the mountain side in a few narrow strips, reaching the summit on the northwest side. We made the ascent from this side. To an elevation of nearly 8,000 feet (2,450 meters) we passed through timber consisting of *Tsuga pattonii* and scattering *Pinus murrayana*, *P. monticola*; and *P. albicaulis*. Leaving this belt we entered that of *Pinus albicaulis*, which extends to the summit, and is the only tree in the upper zone. It is reduced to a low, much gnarled, broken, and often nearly prostrate form."

On the summit Mr. Applegate found *Pentstemon davidsonii*, *Polemonium pulchellum*, *Erigeron compositus*, *Eriophyllum lana-*

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tum, *Oxyria digyna*, *Saxifraga tolmaei*, *Cryptogramma acrostichoides*, *Carex breweri*, *Potentilla glandulosa*, *Raillardella argentea*, *Pulsatilla occidentalis*, a small *Ribes*, an *Arnica*, which he supposed was *cordifolia*, *Spraguea umbellata*, a *Castilleja*, probably *parviflora*, two shrubby species of *Eriogonum*, *Polygonum newberryi*, *Polygonum shastense*, *Lupinus minimus*, *Trisetum subspicatum*, and *Juncus parryi*. He then proceeds:

"Descending from the south side of the mountain, we found nothing new. The character of the mountain appearing from the summit to be about the same on all sides, we did not extend our search in other directions. The whole region lying directly between the mountain and the Lake is a dreary pumice waste, relieved only by an occasional clump of *Tsuga pattonii*, *Pinus murrayana*, and *P. albicaulis*. The principal low vegetation is a species of *Carex* [probably *C. oregonensis*]. The general aspect of the region is that of an over-stocked sheep range. We found red snow [caused by *Sphaerella nivalis*] abundant on the drifts.

Toward the north the country is more broken, several deep canyons heading near the base of Mount Scott and extending toward the northeast. Two of these we crossed. They are full of a good growth of *Tsuga pattonii*. We found no water and few small plants, none of them different from the species growing on the west side of the Lake. In fact, there is probably little of interest on this side until the region lying between Crater Lake and Diamond Lake is reached."

The vegetation about Crater Lake is primarily a great coniferous forest. Most of the mountain slopes are covered by a dense growth of trees consisting principally, at the altitude of the crater slopes, of *Tsuga pattonii*, *Abies nobilis*, *A. lasiocarpa*, *Pinus murrayana* and *P. albicaulis*. The forests are rather dry and have almost no underbrush, not enough to impede a foot-traveler. The commonest shrub is *Ribes erythrocarpum* and the most abundant herbaceous plant *Juncoides glabratum*. Other characteristic plants of the forest are *Rubus lasiococcus*, *Vaccinium membranaceum*, and *Vaccinium scoparium*.

On the gentle outer slopes of the crater occur long stretches of open land entirely devoid of trees and evidently covered until late in the spring with snow. The soil of these open slopes is made up of pulverized pumice with hardly any admixture of humus. The moisture drains from them with extreme rapidity, and the resultant vegetation has a very characteristic appearance. It is not composed of grasses and sedges, but chiefly of scattered herbaceous plants such as *Polygonum newberryi*, *Phlox douglasii*, *Spraguea umbellata*,

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Arenaria pumicola, *Arabis platysperma*, *Polygonum shastense*, and *Eriogonum pyrolaefolium*. The vegetation of these pumice fields is the most remarkable and peculiar feature of the flora.

When springs break out upon level or nearly level ground at the outer base of the crater or on its slopes, little mountain meadows are formed, the vegetation of which is made up primarily of a dense turf of small grasses and sedges. In these meadows occur a number of strikingly handsome or interesting plants such as *Pedicularis groenlandica*, *Dodecatheon alpinum*, *Kalmia glauca*, *Polygonum bistortoides*, *Tofieldia occidentalis*, *Gaultheria myrsinites*, and *Vaccinium caespitosum*.

The vegetation along the precipitous water courses and in the narrow, shaded ravines is somewhat similar to that of the meadows, and is often more or less mixed with it. The more striking plants of such localities are *Mimulus lewisii*, *Veratrum viride*, *Habenaria gracilis*, *Aconitum columbianum*, *Viola glabella*, and *Veronica alpina*.

Upon rocky peaks, such as the Watchman and Castle Crest, occur a series of rupestrine plants, conspicuous among which are *Cryptogramma acrostichoides*, *Oxyria digyna*, *Pulsatilla occidentalis*, *Arabis lyallii*, *Peucedanum martindalei*, *Phyllodoce glanduliflora*, *Pentstemon davidsonii*, and *Hieracium gracile*.

The Lake itself is wholly devoid of aquatic vegetation. No algae, no mosses, and no aquatic flowering plants were found in its waters. The temperature is doubtless too cold during the greater portion of the year to encourage plant growth.

In the catalogue of species I have followed the sequence of families given in Engler and Prantl's *Naturlichen Pflanzenfamilien*, the great German standard of systematic botany. The numbers cited refer to the plants collected by Mr. Leiberg and myself, now deposited in the National Herbarium at Washington, and where no other authority for the occurrence of a plant is given the remarks are based upon my own notes.

In addition, Mr. M. W. Gorman, of Portland, Oregon, has furnished an excellent series of specimens collected by himself at

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Crater Lake; Mr. Elmer I. Applegate, of Klamath Falls, sent in a small collection from Mount Scott, and some additional notes; and Dr. C. Hart Merriam placed at my disposal a few specimens which he collected on Llao Rock.

From these data a list of the principal vegetation growing in the vicinity of Crater Lake has been compiled, with a view chiefly to assist those who may hereafter visit the region in identifying the plants they find there. Such brief descriptive references as the limited space allows have therefore been included in many instances.

From the plants collected at Crater Lake in 1896 the following new species and varieties have been described:

ARENARIA PUMICOLA, Coville & Leiberg.
Proc. Biol. Soc. Wash. xi., 169. 1897.

RANUNCULUS GORMANI, Greene.
Pittonia, iii., 91. 1896.

CARDAMINE BELLIDIFOLIA PACHYPHYLLA, Coville & Leiberg.
Proc. Biol. Soc. Wash. xi., 170. 1897.

RIBES ERYTHROCARPUM, Coville & Leiberg.
Proc. Biol. Soc. Wash. x., 132. 1896.

COLLOMIA MAZAMA, Coville.
Proc. Biol. Soc. Wash. xi., 35. *pl. 1.* 1897.

SAMBUCUS LEIOSPERMA, Leiberg.
Proc. Biol. Soc. Wash. xi., 40. 1897.

EUCEPHALUS COVILLEI, Greene.
Pittonia iii., 163. 1897.

No mosses, lichens, liverworts, or algae are included in the catalogue, as it was impossible with the time at our disposal to make collections and observations in these groups, in none of which, indeed, was the region rich. One alga, however, often becomes a striking feature, namely, the red snow plant, *Sphaerella nivalis*, (Bauer) Sommerfeldt. This is a microscopic, unicellular alga which grows in large quantities in the moist upper layers of the snow-drifts, giving them a conspicuous pink coloration.

Two lichens also are of interest. One, a common bright yellow species, *Evernia vulpina*, (L.) Ach., occurs abundantly in the forests

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on the tree trunks and often ends abruptly at a height of commonly 2.5 to 4 meters (8 to 13 ft.) above the ground. This is said, doubtless correctly, to mark the ordinary depth of snow in winter. The assigned reason for the absence of the lichen on the lower part of the trunk is that it cannot stand continued contact with the snow. This lichen furnishes to the Klamath Indians a canary-yellow dye with which they color the porcupine quills used in weaving the yellow patterns on their baskets.

Another lichen, *Alectoria fremontii*, Tuckerm., which occurs as tufts of black, or sometimes brownish, slender, branching threads hanging to the limbs of the trees, was sometimes used in starvation times as a food among Indians, travelers, and trappers, its preparation consisting of a thorough roasting or steaming among hot stones or in kettles.

CATALOGUE OF SPECIES.

POLYPODIACEAE. (Fern Family).

DRYOPTERIS ACULEATA, (L.) Kuntze. Shield-fern.

A species with rather coarse, simply pinnate fronds; reported by Mr. Gorman from dry rocky clefts about Castle Crest.

CRYPTOGRAMMA ACROSTICHOIDES, R. Br. Rock-brake.

A small, green-stemmed fern with both sterile and fertile fronds finely subdivided as in the next species, but devoid of hairs. It is common in rock crevices about Crater Lake and was found in the lava beds at the northern edge of Wizard Island. Mr. Applegate collected it on Mount Scott.

CHEILANTHES GRACILLIMA, D. C. Eaton. Lip-fern.

A small, brown-stemmed fern divided into many minute, oblong segments, and tomentose on the back. It is a common species on exposed rocks at lower altitudes, and was reported by Mr. Gorman from rocky clefts around Castle Crest.

PINACEAE. (Pine Family).

As the trees of the Pine Family are of such interest and importance, I have included in the catalogue not only those species

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which grow on the mountain at the altitude of Crater Lake but all those which are found along the road from Fort Klamath. The following key is intended as an aid in identification for those who are not familiar with the species of the region:

Leaves in fascicles of two or more.

Leaves 5 in each fascicle; cone-scales without a prickle-like appendage.

Cone ovoid to subglobose, 4 to 7 cm. (1½ to 2¾ in.) long, commonly purple and remaining tightly closed at maturity; body of the seed longer than its wing. **Pinus albicaulis.**

Cone oblong to linear, 12 to 30 cm. (4¾ to 12 in.) in length, commonly brown and readily opening at maturity; body of the seed shorter than its wing.

Cone commonly 20 to 30 cm. (8 to 12 in.) long; body of the seed 9 to 12 mm. (⅓ to ½ in.) in length, the wing seldom twice as long as broad. **Pinus lambertiana.**

Cone commonly 12 to 20 cm. (4¾ to 8 in.) long; body of the seed 5 to 7 mm. (1-5 to 2-7 in.) in length, the wing twice to thrice as long as broad. **Pinus monticola.**

Leaves 2 or 3 in each fascicle; cone-scales with a prickle-like appendage.

Leaves 2 in each fascicle, commonly 3 to 7 cm. (1 1-5 to 2¾ in.) long; cones usually 3 to 5 cm. (1 1-5 to 2 in.) in length; body of the seed about 3.5 mm. (1-7in.) long. **Pinus murrayana.**

Leaves usually 3 in each fascicle, commonly 12 to 25 cm. (4¾ to 10 in.) long; cones usually 7 to 13 cm. (2¾ to 5¼ in.) in length; body of the seed about 6 mm.(¼ in.) long. **Pinus ponderosa.**

Leaves inserted singly on the branchlets.

Leaves opposite or in whorls of three; cones (or berries) not more than 30 mm. (1 1-5 in.) long, the scales not more than 9 and opposite or in whorls of three.

Ultimate branchlets flattened; leaves appressed-adnate, opposite; fruit a cone 20 to 30 mm. (4-5 to 1 1-5 in.) long, the two seed-bearing scales dry and splitting apart at maturity. **Libocedrus decurrens.**

Ultimate branchlets cylindrical; leaves in whorls of three, neither adnate nor appressed; fruit an oblong, blue berry, commonly 5 to 10 mm. (1-5 to 2-5 in.) in length, made up of the united fleshy cone-scales. **Juniperus nana.**

Leaves alternate; cones rarely less than 4 cm. (1 3-5 in.) long, with several to many spirally arranged scales.

Cones pendulous, the scales persistent at maturity.

Cone-scales equaling or shorter than the bracts, the latter conspicuously exposed at all times. **Pseudotsuga mucronata.**

Cone-scales much longer than the bracts, entirely concealing them when closed.

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Leaves always entire; cones 4 to 7 cm. (1 3-5 to 2 4-5 in.) long, almost linear when closed, oblong when expanded; bracts ovate, mucronate, about one-third the length of their scales, most of the exposed surface of the latter pubescent. **Tsuga pattonii.**

Leaves often with minute teeth on the margins; cones 1.5 to 2.5 or even 3 cm. in length, narrowly to broadly oblong when closed, oblong to subglobose when expanded; bracts broadly obovate, 3-lobed, about one-fifth the length of the scales, the exposed surface of the latter glabrous. **Tsuga mertensiana.**

Cones erect, the scales dropping away from the axis at maturity.

Cones about 6 cm. (a little less than 2½ in.) thick; scales exceeded by the conspicuous reflexed bracts. **Abies nobilis.**

Cones 5 cm. (2 in.) or less thick; scales longer than the bracts, the latter entirely concealed within the cone.

Cross-section of the leaf showing the two resin-ducts surrounded on all sides by green tissue; cone purple, typical scales from near the middle with a body one and a quarter to one and a half times as broad as high; body of the seed commonly 6 to 7 mm. (about ¼ in.) long. **Abies lasiocarpa.**

Cross-section of the leaf showing the two resin-ducts lying against the epidermis of the lower surface; cone green; typical scales with a body about twice as broad as high; body of the seed commonly 8 to 9 mm. (about ⅓ in.) long. **Abies concolor.**

PINUS LAMBERTIANA, Dougl. Sugar Pine.

This species occurs only near the base of the mountains, scattered among the Yellow Pines. The tree grows to a greater diameter and height than any other species in the forest; while the tops present a curious and characteristic appearance in sending off long side-branches, few in number, and for the most part clothed with leaves, the large cones often 30 cm. (about a foot) or more in length, hanging pendent from their ends. No. 453.

PINUS MONTICOLA, Dougl. Mountain White Pine.

This is a tree closely resembling the Sugar Pine but of smaller size and with smaller cones. It seldom sends out the long branches so characteristic of the Sugar Pine, and is readily distinguishable by the technical characters given in the key. It grows at a higher altitude than the Sugar Pine, beginning at about 1,500 meters (5,000 ft.) and extending to the altitude of the crater's rim, nearly its upper limit. No specimens of it occurred immediately about the upper camping place though it occurred in the head of Anna Creek

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Canyon, on Wizard Island, on the Phantom Ship, at Red Cloud Cliff, and about the base of Mount Scott, the last three localities on the authority of Mr. Applegate. No. 444.

PINUS ALBICAULIS, Engelm. White-bark Pine.

A few trees of this species occurred about the rim of the crater in the vicinity of the upper camping place and on adjacent elevated points. It also grew sparingly about the edge of the small crater on the summit of Wizard Island. Mr. Applegate reported it as the characteristic and most abundant tree on Mount Scott, occupying a higher altitude than any other species.

PINUS MURRAYANA, Balf. Lodge-pole Pine.

This tree, which is the most widely distributed in altitude of any species occurring in the region, extends from the base of the mountains, in moist soil among the groves of *Pinus ponderosa*, up to the altitude of the crater's rim. At the base of the mountain it has a dark-colored, deeply cracked bark, the outer layers persistent for years, giving to the tree one of its popular local names, Black Pine. At its highest elevation, the tree has a smooth gray bark similar to that of *P. albicaulis*, which results from the shedding of the old layers of bark each year. From the resemblance of the tree in this condition to a tamarack, or larch, it is often called Tamarack Pine. The most abundant growth of the tree occurred on the mountain slope below Pole Bridge at an altitude of 1,500 to 2,000 meters (5,000 to 6,500 ft.), where it was the principal forest tree. Mr. Gorman reported the species on Wizard Island, and Mr. Applegate found it at the base of Mount Scott. No. 445.

PINUS PONDEROSA, Dougl. Yellow Pine.

This is the common and characteristic tree of the lowermost forest belt at the eastern base of the mountains. It occurs in abundance up to an altitude of about 1,500 meters (5,000 ft.). Above this occasional trees are found in warmer exposed localities, usually on south slopes. Within the crater occurred a few trees, some of them on the south shore of the Lake about half a mile west of the boat-landing, where they were seen by Mr. Diller. Mr. Applegate found scattered trees also on the Phantom Ship and along the eastern side of the Lake as far as Red Cloud Cliff.

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TSUGA MERTENSIANA, (Bong.) Carr. Western Hemlock.

A large tree with delicate foliage, the leaves spreading in a single plane. It was reported by Mr. Gorman as occurring on the Rogue river road about 20 kilometers (12 miles) from Crater Lake, among the Yellow Pines, at an altitude of about 1,300 meters (approximately 4,200 ft.).

TSUGA PATTONII, (Jeffr).* Alpine Hemlock.

This is the commonest of the coniferous trees on the mountain slopes immediately about the crater's rim. It occurs almost everywhere both here and at suitable spots on the inner slopes of the crater, as well as on Wizard Island. The young trees show an interesting and instructive peculiarity, namely that of growing in clumps, evidently thus protecting each other from being beaten down in winter by the heavy snows. It commonly happens, therefore, that the old trees grow close together in groups of two to four. No. 451.

PSEUDOTSUGA MUCRONATA, (Raf.) Sudw. Hemlock Spruce.

This widespread tree of the Rocky Mountain region and the Northwest Coast, which passes under various names, such as Douglas Spruce, Oregon Fir, Oregon Pine, and Red Fir, occurs in the Crater Lake region only in small amounts and far down Anna Creek Canyon, growing in company with the Yellow Pine and the Post Cedar. No. 435.

ABIES LASIOCARPA, (Hook.) Nutt. Alpine Fir.

This is usually a small tree with smooth bark and an extremely narrow columnar figure, bearing its purplish cones on the uppermost branches. The first trees of it seen in ascending the mountain were near the spring just below Pole Bridge. About the rim of the crater and on the inner slope it was of frequent occurrence, and a single tree was seen on Wizard Island, near the northernmost point of the lava flow. No. 443.

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*The first technical description of this tree is ascribed to an obscure publication known as the Report of the Oregon Committee, which was issued at Edinburgh in the year 1853, about the month of September. The name under which it was there published was *Abies pattoniana*. It now appears however that the tree was really first described in a circular issued by the same committee September 4, 1852, under the name *Abies pattonii*. I have therefore adopted the latter name, as did Gordon, in the first edition of his "Pinetum."

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ABIES CONCOLOR, (Gord.) Lindl. White Fir.

This tree occurred in company with the Yellow Pine at the foot of the mountain slope, and Mr. Applegate found a few trees within the crater's rim at the foot of Red Cloud Cliff. The species is common in the Rocky Mountains and in the Sierra Nevada of California, extending into the Cascades of Southern Oregon. It is closely related to *Abies grandis*, Lindl., of Western Oregon and the northern Cascades, but is distinguishable by its leaves, which have a pale green color, with stomata and usually some glaucousness, or bloom, on both surfaces, while the leaves of *Abies grandis* are dark green and devoid of stomata on the upper surface, but provided beneath with a sharply defined glaucous stripe, covered with stomata, on either side of the midrib.

ABIES NOBILIS, Lindl. Noble Fir.

This, the most magnificent tree of the region, began to occur at an altitude of about 1,400 meters (4,600 ft.), and from about 1,500 meters (5,000 ft.) to the crater's rim it was an abundant and characteristic species, above Pole Bridge sharing with the Alpine Hemlock most of the space in the forests. It occurred on the inner slope of the crater and on Wizard Island. The branchlets of the tree, when viewed from beneath, present a peculiarly regular pattern of almost geometric exactness, and with a little experience one can readily identify this among the other firs by this feature alone. The bark, when broken, presents a deep red-brown color quite different from that of either of the other firs. A curious characteristic of the full-grown but yet unripe cones is the bright red color of the seed wings, which is very strikingly displayed when the cones are broken. This coloration is probably not a functional one, for when the cones are mature the wings turn brown as in other species. No. 441.

LIBOCEDRUS DECURRENS, Torr. Incense Cedar.

A tree with the habit of an Arbor Vitae, growing only at low altitudes on the mountains in company with the Sugar Pines and Yellow Pines. No. 436.

JUNIPERUS NANA, Willd. Dwarf Juniper.

A prostrate shrub with awl-shaped leaves, found by Mr. Gorman on dry rocky slopes near the Watchman.

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TAXACEAE. (Yew Family).

TAXUS BREVIFOLIA, Nutt. Yew.

A small tree, resembling a spruce or hemlock but bearing, in place of cones, scarlet fleshy berries, the naked brown seed of which is half inclosed in a depression at the apex. It was reported by Mr. Gorman as occurring on the Rogue river road at an altitude of about 1,050 meters (approximately 3,500 feet).

POACEAE. (Grass Family).

PHLEUM ALPINUM, L.

This grass was seen by Mr. Leiberg along Anna Creek below the spring.

CALAMAGROSTIS CANADENSIS, (Michx.) Beauv.

In springy places on Castle Crest, the specimens referable to the variety *acuminata*, Vasey. No. 412.

DESCHAMPSIA ATROPURPUREA, (Wahl.) Scheele.

On Castle Crest and about meadows and springs in many other places; only the variety *latifolia*, (Hook.) Scribn., found. No. 411.

TRISETUM SUBSPICATUM, (L.) Beauv.

In crevices of rocks and other rather dry situations; collected on the rim of the crater about 0.8 kilometer (half a mile) west of the upper camping ground. No. 433.

POA, sp.

No specimens of Poa were collected, though they were observed on Wizard Island and sparingly in the vicinity of the camping place. The species could not therefore be identified.

PANICULARIA PAUCIFLORA, (Presl.) Kuntze.

Seen in only a single spot, a springy place on Castle Crest. No. 392.

BROMUS SUKSDORFII, Vasey.

Abundant in an area of burned forest at the outer foot of the crater, south of the Watchman. No 423.

BROMUS BREVIARISTATUS, Buckley.

Abundant in dry pumice soil between Castle Crest and Vidae Cliff. No. 379.

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CYPERACEAE. (Sedge Family).

CAREX AURICULATA, Bailey.

Specimens doubtfully referred to this species by Professor L. H. Bailey, to whom they were submitted for identification, were collected in the ravine of Pole Bridge Creek a short distance below the bridge. No. 334.

CAREX BREWERI, Boott.

A densely tufted low species with slender, cylindrical leaves, distinguishable from all the others of the vicinity by its single instead of two to several spikes. It occurred in dry pumice soil on the slopes of the Watchman, between Castle Crest and Vidae Cliff, and on Mount Scott, where it was collected by Mr. Applegate. No. 384.

CAREX GOODENOWII, J. Gay.

One of the several forms of this species was collected in a wet meadow at the outer base of the crater, south of the Watchman. No. 413.

CAREX OREGONENSIS, Olney.

This species, the only one seen with hairy perigynia, was abundant in a burned tract in the vicinity of Pole Bridge. It occurred frequently on the open forest lands and made up the greater amount of the scanty forage the region afforded. No. 345.

CAREX, sp.

Other species of Carex will doubtless be found about Crater Lake, but none in condition for identification were seen at the season of our visit.

JUNCACEAE. (Rush Family).

JUNCUS MERTENSIANUS, Bong. Rush.

A species with leafy stems and nearly black, subspherical heads of flowers. It was seen only at the foot of the trail to the Lake. No. 358.

JUNCUS PARRYI, Engelm.

A frequent species in the vicinity of snow-drifts, common about the camping place. It was seen also in the crater of Wizard Island and was reported from Mount Scott by Mr. Applegate. It differs

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from the following species in its acute capsules, and in the presence of well developed blades upon its leaf-sheaths.

JUNCUS SUBTRIFLORUS, (E. Mey.) Coville.

A species inhabiting rock crevices, particularly when well supplied with moisture. Its leaves are reduced to bladeless sheaths, while its capsules are truncate or retuse at the apex. No. 346.

JUNCOIDES GLABRATUM, (Hoppe) Sheldon. Wood Rush.

A plant with broad, bright green, shining, grass-like leaves and a dark, cymose inflorescence, very abundant in the forests, often carpeting the ground over large areas. While very green in appearance and often supposed by campers to be valuable for stock food, horses will not eat it unless almost starved. No. 342.

JUNCOIDES PARVIFLORUM, (Ehrh.) Coville.

A species similar to the last but readily distinguishable by its pale and dull leaves, and by its smaller flowers and fruit. It was seen only at a single point on the trail down to the Lake. No. 388.

LILIACEAE. (Lily Family).

TOFIELDIA OCCIDENTALIS, Wats.

In one of the meadows at the outer base of the crater slope south of the Watchman. No. 416.

VERATRUM VIRIDE, Ait. False Hellebore.

Patches of it were not uncommon in moist, open soil and along streams in the vicinity of the upper camping place. No. 438.

CLINTONIA UNIFLORA, (Menz.) Kunth.

Flowering specimens were collected by Miss Cunningham of Fort Klamath in a moist spot in the woods near the lower camping place. The plant resembles a Lily of the Valley, but bears only one or two large white flowers. Mr. Gorman also reported it. No. 439.

VAGNERA AMPLEXICAULIS, (NUTT.) Greene. False Solomon's Seal.

In crevices of rocks and among loose boulders, on the slopes of Castle Crest. No. 394.

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STREPTOPUS AMPLEXIFOLIUS, (L.) DC. Twisted-stalk.

Seen only in the ravine of Pole Bridge Creek. No. 329.

STREPTOPUS ROSEUS, Michx.

Collected in the same locality as the last. The specimens are much smaller than usual, the leaves not so broad at the base as in the eastern plant, and the flowers on somewhat shorter peduncles. No. 333.

HABENARIA LEUCOSTACHYS, (Lindl.) Wats.

A plant similar to the last but with pure white flowers. Reported by Mr. Gorman from a moist meadow near the head of Anna Creek.

ORCHIDACEAE. (Orchid Family).

HABENARIA GRACILIS, (Lindl.) Wats. Rein-orchis.

A leafy-stemmed plant with a spike of greenish-white flowers, growing along streams. No. 335.

LISTERA CONVALLARIOIDES, (Sw.) Torr. Tway-blade.

A delicate little orchid with two opposite, broadly ovate leaves in the middle of the stem, and a delicate, short raceme of yellowish-green flowers. Along the trail to the Lake. No. 361.

CORALLORHIZA MERTENSIANA, Bong. Coral-root.

A leafless, purplish-brown plant found in dry soil under the trees, on the trail to the Lake shore. The plant was collected also by Mr. Gorman but it evidently is not abundant. No. 360.

SALICACEAE. (Willow Family).

SALIX GLAUCA, L. Willow.

Collected at the spring at the head of Anna Creek, in the form of the variety *villosa*, (Hook.) Anders. No. 396.

BETULACEAE. (Birch Family).

ALNUS ALNOBETULA, (Ehrh.) K. Koch. Green Alder.

This shrub, more commonly known under the technical name *A. viridis*, (Chaix) DC., was seen in only one place, near the trail down the inner slope of the crater. No. 364.

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FAGACEAE. (Oak Family).

CASTANOPSIS CHRYSOPHYLLA, (Hook.) DC. Chinquapin.

The shrubby form of this plant, variety *minor*, (Hook.) A. DC., was seen by Dr. Merriam near the crater's rim about 2 kilometers (a mile and a quarter) northwest of the upper camping place, and a single specimen of it was also reported by Mr. Applegate on Wizard Island. These are the only stations of which I have a record.

POLYGONACEAE. (Buckwheat Family).

ERIOGONUM OVALIFOLIUM, Nutt.

A species of frequent occurrence, with white or pinkish flowers, the small orbicular leaves densely white—tomentose on both surfaces. Specimens were collected on Llao Rock by Dr. Merriam.

ERIOGONUM PYROLAEFOLIUM, Hook.

This species in the form of the variety *coryphaeum*, Torr. & Gr., occurred in the pumice fields about the camping place and in similar situations elsewhere around the crater. It attained an unusual development on Wizard Island, on the steep slopes of the cinder cone, and was collected also by Dr. Merriam on Llao Rock. It is a species with ovate, usually acute leaves densely white-tomentose beneath, more sparingly and loosely tomentose over the green upper surface, and with flowers of a greenish-white color. No. 383.

ERIOGONUM STELLATUM, Benth.

A shrubby, branching, yellow-flowered species commonly 30 cm. (1 ft.) in height, its leaves similar to those of the next. Collected by Mr. Gorman.

ERIOGONUM UMBELLATUM, Torr.

A depressed, matted, yellow-flowered species, its foliage somewhat similar to that of *ovalifolium*, but the upper surface of the leaves green and usually devoid of pubescence. Not uncommon; collected on Llao Rock by Dr. Merriam.

RUMEX ACETOSELLA, L. Sheep Sorrel.

This, the only introduced plant seen at Crater Lake, was found sparingly near the upper camping place.

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OXYRIA DIGYNA, (L.) Camptd. Mountain Sorrel.

Observed by Mr. Leiberg in rocky crevices on Castle Crest and collected by Mr. Applegate on Mount Scott.

POLYGONUM BISTORTOIDES, Pursh.

A slender-stemmed plant springing from a red tuber and bearing a short, dense spike of white flowers. It occurred sparingly in wet meadows. No. 336.

POLYGONUM NEWBERRYI, Small.

The most conspicuous and abundant plant of the pumice fields, its broad leaves and large, thick roots giving it somewhat the character of a dock. No. 338.

POLYGONUM SHASTENSE, Brewer.

A low, shrubby species, seldom more than 10 cm. (4 in.) in height, with pinkish-white flowers, and small oblong leaves with revolute margins. This was a common species in the pumice fields about the camping place. No. 373.

PORTULACACEAE. (Portulaca Family).

CLAYTONIA LANCEOLATA, Pursh. Spring Beauty.

A species with a pair of opposite, sessile, flat, lanceolate, 3-nerved leaves; frequent in somewhat moist places in the forest. The subspherical tubers are commonly eaten by squirrels, and the holes where they have dug for them were frequently observed. No. 424.

OREOBROMA TRIPHYLLA, (Wats.) Howell.

A plant very similar to the last and with similar tubers, but with a pair of fleshy, nearly cylindrical leaves. It was found on Castle Crest by Mr. Leiberg, and was reported also by Mr. Gorman from the slopes and moraines at the head of Anna Creek.

SPRAGUEA UMBELLATA, Torr.

One of the commonest plants of the pumice fields; the flowers varying in color from white to purplish. This plant shows an interesting adaptation to protection against cold at night. The base of the flowering peduncle is enlarged, and when the sun is shining

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the pressure on the lower side of this swelling is such as to push the peduncle to a nearly upright position. At sunset, however, this pressure gives way to a pressure on the upper side of the swelling, and the peduncle is thrown back against the ground. In this position the plant undoubtedly is able to withstand a much greater degree of cold without harm than if it stood erect during the frosty nights.

ALSINACEAE. (Pink Family).

SILENE MONTANA, Wats.

On a moist talus slope of Castle Crest. No. 390.

ALSINE BOREALIS, (Bigel.) Britton.

In the ravine of Pole Bridge Creek. A small plant, resembling the common chickweed. No. 337.

SAGINA OCCIDENTALIS, Wats.

A tufted, moss-like plant, collected in a wet meadow at the base of the outer slope of the crater, south of the Watchman. No. 410.

ARENARIA PUMICOLA, Coville & Leiberg.

A tufted, perennial species, with pale green leaves and glandular inflorescence, growing everywhere about the pumice fields. No. 349.

RANUNCULACEAE. (Buttercup Family).

AQUILEGIA FORMOSA, Fisch. Columbine.

On Castle Crest; in moist soil.

ACONITUM COLUMBIANUM, Nutt. Monkshood.

Found in wet places on the slopes of Castle Crest. No. 395.

PULSATILLA OCCIDENTALIS, (Wats.) Freyn. Anemone.

Among rocks on the slopes of the Watchman and of Castle Crest. A hairy plant with much divided leaves, and a large, snow-white, conspicuous flower. No. 374.

RANUNCULUS ESCHSCHOLTZII, Cham. & Schlecht. Buttercup.

A species with deeply lobed leaves, found near the rim of the crater, about a kilometer (⅔ mile) west of the upper camping ground. No. 430.

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RANUNCULUS GORMANI, Greene.

A delicate plant, with a basal cluster of long-peduncled, ovate to ovate-lanceolate leaves rounded at base, and usually somewhat angularly denticulate; the one-flowered stems decumbent and often rooting at the base, then ascending. Described by Professor E. L. Greene from specimens collected by Mr. Gorman at a spring on Castle Crest, and on moist creek banks at the head of Anna Creek. It was collected also in the latter locality by Mr. E. I. Applegate.

FUMARIACEAE. (Fumitory Family).

BIKUKULLA FORMOSA, (Andr.) Coville. Bleeding Heart.

In Anna Creek Canyon, near the spring, in the ravine of Pole Bridge Creek, and on Wizard Island. A plant with showy, pale purplish-red flowers, similar to those of the cultivated Bleeding Heart or the Squirrel-root of the Eastern States. No. 331.

BIKUKULLA UNIFLORA, (Kell.) Howell.

A delicate, one-flowered plant found only on the bare ground at the junction of the stream from the Anna Creek spring with the first ravine from the north. Only fruiting specimens were seen at the time of our visit, the capsule lying flat on the ground.

BRASSICACEAE. (Mustard Family).

BARBAREA STRICTA, Andrz. Yellow Rocket.

Collected by Mr. Gorman on sandy slopes near the upper camping ground.

RORIPA CURVISILIQUA, (Hook.) Bessey.

A low, yellow-flowered plant with pinnatifid leaves. Reported on moist slopes about the head of Anna Creek by Mr. Gorman.

CARDAMINE BELLIDIFOLIA, L.

Occurring only in the form of the variety *pachyphylla*, Coville & Leiberg. A small, Arabis-like perennial, with long-stalked, obovate leaves and a short scape-like stem, bearing rose-purple to white flowers. Collected on the slopes of the Watchman, and reported also by Mr. Gorman from the vicinity of Glacier Peak. No. 426.

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CARDAMINE OLIGOSPERMA, Nutt.

A delicate annual with small, white flowers and pinnately divided leaves; growing along streams or about springs. Collected by Mr. Gorman near the springs at the head of Anna Creek.

ARABIS PLATYSPERMA, Gray.

Abundant in the pumice fields. Usually glabrous and glaucous, with smooth, erect pods often 5 mm. (1-5 in.) in breadth. No. 425.

CRASSULACEAE. (Stonecrop Family).

COTYLEDON OREGONENSIS, Wats.

This thick-leaved, yellow-flowered plant grew on exposed rocks in the vicinity of Pole Bridge, and also in the ravine at the south foot of Castle Crest. No. 326.

SEDUM SPATHULIFOLIUM, Hook.

Smaller than the last, the petals distinct instead of united below, and the flowers secund on divergent branches instead of paniculately cymose. Found by Mr. Gorman. on rocky cliffs near Castle Crest.

SAXIFRAGACEAE. (Saxifrage Family).

SAXIFRAGA INTEGRIFOLIA, Hook. Saxifrage.

A species with greenish flowers, found by Mr. Leiberg in moist soil near the head of Anna Creek.

SAXIFRAGA NOTKAMA, Moc.

A plant with a basal rosette of toothed leaves, producing an open panicle with a few white, delicate, yellow-spotted flowers at the ends of the branches, and a large number of green bulblets. Found on moist rocks on the inner slope of the crater, along the trail down to the Lake. No. 366.

SAXIFRAGA TOLMAEI, Torr. and Gr.

Found on the inner slope of the crater near the head of the trail to the Lake and collected also by Mr. Applegate on Mount Scott. The plant occurs in dense mats with small, thick, entire, shining leaves, and sends up stems bearing commonly from one to three white flowers. No. 351.

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MITELLA BREWERI, Gray.

A species of deep, moist ravines, growing along Pole Bridge Creek and near the stream leading from the Anna Creek spring. It is distinguished from *pentandra* by the brown flexuous hairs on its petioles and by the position of its stamens opposite the calyx lobes. No. 339.

MITELLA PENTANDRA, Hook.

Collected near the trail to the Lake on the inside slope of the crater. The plant has a few stiff bristly hairs upon the leaf-blades and petioles, while the stamens are set opposite the petals. No. 356.

RIBES VISCOSISSIMUM, Pursh. Currant.

A large-leaved, thornless currant growing often to the height of a meter, its herbage having the odor of citronella oil. It bears some resemblance to the following species, but in addition to its greater size, odor, and certain distinctive flower characters, it produces a black, glaucous fruit.

RIBES ERYTHROCARPUM, Coville & Leiberg.

The commonest currant of the vicinity, growing almost everywhere in the forest, the type specimens being collected in the canyon of Pole Bridge Creek and on the slopes about Castle Crest. It is a trailing shrub, seldom rising more than 20 cm. (8 in.) above the ground. It bears no thorns, has a rank odor, and produces a scarlet, insipid berry. Nos. 341, 367, and 378.

RIBES CEREUM, Dougl.

Found by Dr. Merriam on a steep rocky slope near the large, gushing spring between Pole Bridge and the lower camping ground, and common at lower altitudes.

RIBES LACUSTRE, (Pers.) Poir.

The only thorny species of *Ribes* growing in the vicinity. It occurred sparingly, being found on Wizard Island, on Castle Crest, and near the Lake shore at the foot of the trail.

ROSACEAE. (Rose Family).

SPIRAEA ARBUSCULA, Greene. Spiraea.

A shrub half a meter to a meter in height, bearing small cymes

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of lilac-purple flowers. It occurred, though not in abundance, at several points in moist places in the forest. No. 437.

HOLODISCUS DISCOLOR, (Pursh) Maxim.

A white-flowered shrub somewhat similar to the last. It was found on exposed rocks near Pole Bridge, and occurred also on Wizard Island. Dr. Merriam found it abundant on Llao Rock. No. 328.

SORBUS SAMBUCIFOLIA, (Cham. & Schlecht.) Roem. Mountain Ash.

A shrub or small tree with alternate pinnately compound leaves and broad cymes of white flowers. It was found on Wizard Island and in Anna Creek Canyon.

RUBUS LASIOCOCCUS, Gray. Raspberry.

A trailing plant with trifoliolate or trilobate leaves, somewhat similar to a strawberry in general appearance, but with single flowers and somewhat woody stems. It was common throughout the forests. No. 340.

POTENTILLA GELIDA, C. A. Meyer.

A low species with bright yellow flowers; found in moist soil about the spring at the head of Anna Creek. The American form of the species is known as variety *flabellifolia*, (Hook.) Rydberg. No. 402.

POTENTILLA GLANDULOSA, Lindl.

An erect, stout, glandular-hairy plant with yellow flowers, doubtfully referred to this species; reported from Castle Crest and Mount Scott and doubtless of not infrequent occurrence on rocky slopes.

LUETKEA PECTINATA, (Pursh) Kuntze.

Along the trail to the Lake, on the inner slope of the crater. The plant formed carpet-like mats upon the ground, sending up short racemes of white flowers, the stalk bearing below a series of narrowly cleft leaves.

VICIACEAE. (Bean Family).

LUPINUS LAXIFLORUS, Dougl. Lupine.

An erect plant commonly 30 cm. (1 ft.) high, with usually pale flowers, doubtfully referred to this species. Common everywhere in the pumice soil.

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LUPINUS MINIMUS, Dougl.

A small tufted species with short dense racemes of bright blue flowers; abundant in the pumice fields everywhere about the crater. Only a revision of the group can settle the proper disposition of this plant and the preceding.

LUPINUS RIVULARIS, Dougl.

Found along Anna Creek not far below the spring; a large bright green plant a meter or more in height. No. 338.

TRIFOLIUM LONGIPES, Nutt. Clover.

A species with white or pale purplish ascending flowers, not uncommon in the forests. Nos. 400 and 419.

TRIFOLIUM KINGII, Wats.

A species with purple, reflexed flowers found at only one point, along the road between the Rogue River fork and the lower camping ground. No. 368.

ACERACEAE. (Maple Family).

ACER GLABRUM, Torr. Dwarf Maple.

A shrub or small tree found at only one point, along the trail to the boat-landing on the inner slope of the crater. No. 257.

VIOLACEAE. (Violet Family).

VIOLA BLANDA, Willd.

A small white-flowered species; reported by Mr. Applegate and Mr. Gorman from wet meadows and slopes about the crater.

VIOLA CANINA, L.

A form of this blue-flowered, long-spurred species was reported by Mr. Gorman from moist slopes about the head of Anna Creek.

VIOLA GLABELLA, Nutt.

A yellow-flowered species with long petioles and broadly cordate leaf-blades, found in the ravine of Pole Bridge Creek and near the head of Anna Creek. No. 332.

VIOLA NUTTALLII, Pursh.

A plant with large yellow flowers and smooth, narrowly oblong,

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light green leaves, frequent in pumice fields immediately about the upper camping place. No. 347.

VIOLA PURPUREA, Kell.

A species somewhat similar to the last but with smaller, sometimes purplish flowers and conspicuously veined leaves. It occurred in open soil on rather moist stony slopes. No. 330.

ONAGRACEAE. (Evening-primrose Family).

EPILOBIUM ALPINUM, L.

A plant about 30 cm. (12 in.) high with lanceolate-ovate leaves, long-stalked capsules and branched inflorescence. In a meadow at the outer base of the crater, south of the Watchman. No. 418.

EPILOBIUM SPICATUM, Lam. Fire-weed.

A tall plant often a meter in height, with a large raceme of conspicuous lilac-purple flowers. Seen only on Wizard Island.

EPILOBIUM CLAVATUM, Trelease.

A tufted species with small thick oval leaves, long-stalked capsules, and distinctly papillose seeds. Collected on the wet slopes of Castle Crest. No. 393.

EPILOBIUM ANAGALLIDIFOLIUM, Lam.

A small plant, commonly not more than 10 cm. (4 in.) in height. Collected near Pole Bridge. No. 344.

EPILOBIUM GLABERRIMUM, Barbey.

Found only in the form of the variety *fastigiatum*, (Nutt.) Trelease, a tufted plant with lanceolate-ovate, rather thin and somewhat glaucous leaves and sessile or nearly sessile capsules. Collected on the wet slopes of Castle Crest. No. 389.

EPILOBIUM HORNEMANNI, Reich.

Similar to *E. alpinum* but usually unbranched and with sessile capsules. In wet soil on Castle Crest. No. 391.

GAYOPHYTUM LASIOSPERMUM, Greene.

Some specimens of *Gayophytum* perhaps referable to this species were seen at Crater Lake, but unfortunately none were collected.

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APIACEAE. (Parsley Family).

Of the four species of this family collected at Crater Lake and submitted to Dr. J. N. Rose for examination, only one is in condition for identification. Fruiting specimens of the others should be collected by later visitors.

ANGELICA sp.

A tall, coarse plant with ternately compound leaves and white flowers. Found on a grassy slope of the Watchman by Mr. Gorman.

SIUM (?) sp.

A tall plant, a meter or more in height, bearing a single compound umbel of white flowers, the simply pinnate leaves with dentate, oblong or ovate leaflets; probably an undescribed species of this genus or some genus with similar foliage. Found in a wet meadow at the outer base of the crater rim south of the Watchman. No. 417.

LIGUSTICUM APIIFOLIUM, (Nutt.) Gray.

A white-flowered plant with somewhat ternately decompound leaves and a sweet-scented root; doubtfully referred to this species. Collected near a stream by Mr. Gorman.

PEUCEDANUM MARTINDALEI, Coult. & Rose.

A low plant with yellow flowers and 1 to 3 spreading, glaucous, much divided leaves; of frequent occurrence on steep pumice slopes. Nos. 369, 382, and 387.

PYROLACEAE. (Pyrola Family).

CHIMAPHILA MENZIESII, Spreng.

Found only in dry soil under the trees along the trail down the inner slope of the crater. The plant has dark green, elliptical-oblong, acute, serrate leaves and one or two handsome flowers.

CHIMAPHILA UMBELLATA, (L.) Nutt.

Similar to the last but with narrower leaves and several flowers. Observed upon Wizard Island and reported by Dr. Merriam as abundant in the forest northwest of the Watchman.

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PYROLA SECUNDA, L.

A small species with a one-sided raceme of greenish-white flowers. Found along the trail to the boat-landing and on Wizard Island. No. 354.

PYROLA DENTATA, Smith.

A species with narrowly oblong or spatulate, usually obtuse, often entire, glaucous leaves, found only on the slopes of the crater on Wizard Island. No. 386.

PYROLA PICTA, Smith.

A species closely related to the last but with ovate, usually acute, dark green leaves marked along the veins with light green or almost white. Found both on Wizard Island and in the woods on the mainland.

MONOTROPACEAE. (Indian-pipe Family).

ALLOTROPA VIRGATA, Torr. & Gr.

A leafless, erect plant of white, waxen color, commonly 20 to 30 cm. (8 to 12 in.) in height. Found only on Wizard Island. No. 385.

HYPOPITYS HYPOPITHYS, (L.) Small. Pine-sap.

A yellowish-brown plant much lower than the last, the inflorescence recurved in the bud and becoming erect as the flowers open. Collected in moist woods about the head of Anna Creek.

PTEROSPORA ANDROMEDEA, Nutt. Pine-drops.

A leafless, erect plant of reddish-brown color, often half a meter (20 in.) in height. Reported by Mr. Applegate from the inner slope of the crater at Red Cloud Cliff.

ERICACEAE. (Heath Family).

KALMIA GLAUCA, Ait.

A low shrub with rose-colored flowers and smooth, ever-green leaves glaucous on the lower surface and with revolute margins. In the wet meadows near the spring at the head of Anna Creek. No. 299.

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PHYLLODOCE GLANDULIFLORA, (Hook.) Coville.

A low, heather-like, shrubby plant with pale yellow, nearly closed, bell-shaped flowers. Found among the rocks on the slopes of the Watchman.

Following both Bentham and Hooker, and Engler and Prantl in maintaining *Phyllodoce* as a genus distinct from *Bryanthus*, Dr. Gray's *Bryanthus glandulifiorus* (*Menziesia glandulifiora*, Hook.) is here transferred to *Phyllodoce*.

GAULTHERIA MYRSINITES, Hook.

A small, prostrate plant with evergreen, orbicular leaves and small, white or pink, bell-shaped flowers. In small quantities along the stream below the spring at the head of Anna Creek. No. 440.

ARCTOSTAPHYLOS NEVADENSIS, Gray. Manzanita.

A prostrate shrub with evergreen, ovate or obovate usually acute leaves, reddish-brown bark, and smooth fruit. This was infrequent immediately about the crater, but it occurred abundantly in the forest at lower altitudes. It was found by Mr. Applegate at Red Cloud Cliff.

VACCINIUM CESPITOSUM, Michx.

A low shrub with oblanceolate, usually obtuse leaves and cylindrical branches. Near the spring at the head of Anna Creek. No. 407.

VACCINIUM MEMBRANACEUM, Dougl. Huckleberry.

This tall species of Huckleberry, more commonly known to botanists under the name *V. myrtilloides*, Hook., is said to be the most productive of all the huckleberries of the region. This is the fruit for which the Klamath Indians make their annual pilgrimage to Huckleberry Mountain, southwest of Crater Lake.

VACCINIUM MYRTILLUS, L.

A small, black-fruited species with angular stems. This Mr. Leiberg thinks he saw near the head of Anna Creek.

VACCINIUM SCOPARIUM, Leiberg.

This is a low shrub, usually not more than 20 cm. (8 in.) in

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height, with angular stems, small leaves, and red fruit. It is common almost everywhere in the forests. No. 352.

This is Hooker's variety *microphyllum* of *Vaccinium myrtillus*, which with its lower stature and broom-like habit, smaller leaves, obsolescent calyx lobes, and red fruit, appears well distinguished from *V. myrtillus*.

PRIMULACEAE. (Primrose Family).

DODECATHEON ALPINUM, Greene. Shooting Star.

A small perennial plant with a tuft of basal leaves and a scape bearing an umbel of inverted, pink or purple flowers. Of frequent occurrence in moist meadows and about springs at various points in the vicinity of Crater Lake. Probably other species occur there also.

POLEMONIACEAE. (Polemonium Family).

PHLOX DOUGLASII, Hook. Phlox.

One of the most conspicuous plants of the pumice fields, producing a profusion of white or pale rose-colored flowers. This is the form known as variety *diffusa*, Gray.

GILIA AGGREGATA, (Pursh) Spreng.

A tall, biennial plant about half a meter (20 in.) in height, with a panicle of long, tubular, scarlet flowers. This occurs in the forests, principally at lower altitudes than Crater Lake, though it was seen near the lower camping place and in the woods near the head of Anna Creek.

POLEMONIUM PULCHELLUM, Bunge.

A low, tufted, blue-flowered, glandular-hairy perennial with pinnate leaves. Collected on Castle Crest. No. 376.

COLLOMIA TINCTORIA, Kellogg.

A small annual, with narrow, acute leaves, glandular pubescence, and minute purplish flowers. It was seen only in dry, open, woodland soil near the outer base of the crater rim southward from the Watchman. No. 405.

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COLLOMIA MAZAMA, Coville.

A tufted perennial plant commonly 12 to 20 cm. (5 to 8 in.) high, with glandular, rank-scented herbage and handsome, conspicuous, blue flowers. This plant grows in abundance in slightly moist, open, sparingly grassy places in the forest, in the vicinity of streams and wet meadows, about 5 kilometers (3 1-10 miles) west of the upper camping ground at Crater Lake, south of the Watchman at an elevation of 1,800 to 1,900 meters (5,900 to 6,200 ft.), and continues southeastward at about the same altitude, at least as far as the lower camping ground, about 2½ kilometers (1½ miles) south of the rim of the Lake. For one starting from the junction of the Rogue River and Fort Klamath roads and traveling northward toward Crater Lake, the most convenient and probably the first place for finding the plant is on the flat ground where the road first crosses the stream on which the lower camping ground is situated. Specimens were seen here but not in abundance. At the time of collecting (Aug. 15), the species was in full flower, and very few of the specimens had produced mature seeds.

HYDROPHYLLACEAE. (Waterleaf Family).

PHACELIA MAGELLANICA, (Lam.) Coville.

A plant appearing in several forms of diverse appearance, but all referable, in the state of our present knowledge of the group, to this species. Not uncommon in dry, exposed places; one form collected on Llao Rock by Dr. Merriam. No. 432.

BORRAGINACEAE. (Borage Family).

LAPPULA DIFFUSA, (Lehm.) Greene. Forget-me-not.

A tall, branching plant usually growing along streams in moist places and bearing small blue flowers closely resembling those of the common cultivated forget-me-not. It was reported from the head of Anna Creek by Mr. Leiberg.

SCROPHULARIACEAE. (Figwort Family).

COLLINSIA PARVIFLORA, Lindl.

A small annual with blue and white flowers. Reported by Mr. Leiberg from Castle Crest.

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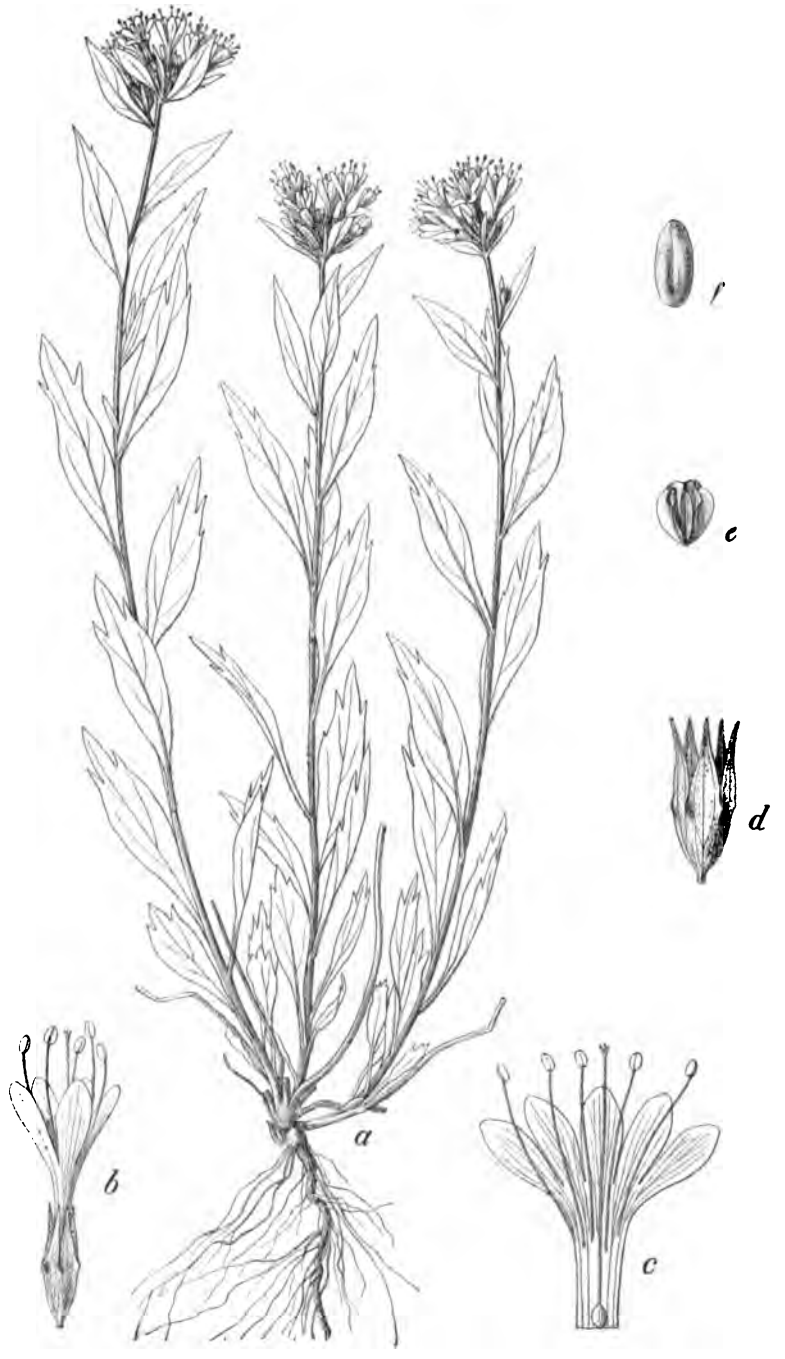

COLLOMIA MAZAMA.

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PENTSTEMON CONFERTUS, Dougl.

A loosely tufted, smooth perennial with narrowly oblong leaves acute at both ends, and a narrow, erect panicle of blue flowers, constituting the variety *procerus*, (Graham) Coville. Collected on the crater rim west of the upper camping ground and abundant at the lower camping ground. No. 420.

PENTSTEMON DAVIDSONII, Greene.

A depressed species with small, obovate, entire leaves and large, blue flowers. Of frequent occurrence on rocks about the crater.

PENTSTEMON NEWBERRYI, Gray.

A species similar to the last but with serrate leaves and light red flowers, found near the bottom of the trail to the boat-landing; nearly past flowering at the time of our visit.

MIMULUS LEWISII, Pursh.

A tall herbaceous plant with pale-red conspicuous flowers, the foliage often with a musky odor. Found about the spring at the head of Anna Creek and near the foot of the trail to the boat landing.

MIMULUS PRIMULOIDES, Benth.

A small, depressed, matted yellow-flowered plant. Collected by Mr. Applegate near the spring at the head of Anna Creek.

VERONICA ALPINA, L.

A small, slender perennial with opposite leaves and a terminal raceme of small blue flowers. Not uncommon in moist grassy places. No. 422.

VERONICA SERPYLLIFOLIA, L.

In moist places; collected by Mr. Gorman.

CASTILLEJA PARVIFLORA Bong. Paint Brush.

An almost shrubby perennial with conspicuous scarlet bracts on the flowering spikes. Not uncommon about the crater, and collected also by Mr. Applegate on Mount Scott. No. 380.

ORTHOCARPUS PILOSUS, Wats.

A plant somewhat similar to the preceding, but differing in its much less conspicuous and smaller, pale red or yellow bracts, and in

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its smaller flowers about 1.5 cm. (3-5 in.) long. Common on pumice slopes. Nos. 303 and 304.

PEDICULARIS GROENLANDICA, Retz.

A plant of wet meadows such as those about the spring at the head of Anna Creek and those at the outer base of the crater rim south of the Watchman. The rose-purple flowers closely resemble in miniature the head of an elephant.

PEDICULARIS RACEMOSA, Dougl.

This plant occurred in abundance on the south and southeast slopes of the cone on Wizard Island where its rose-purple flowers are a conspicuous and striking feature of the vegetation. Dr. Merriam found it common in the woods northwest of the Watchman.

RUBIACEAE. (Madder Family).

KELLOGGIA GALIOIDES, Torr.

Found sparingly in the forests about the head of Anna Creek.

VIBURNACEAE. (Honeysuckle Family).

SAMBUCUS LEIOSPERMA, Leiberg. Red Elder.

A shrub with white flowers, scarlet fruit, and opposite compound leaves; growing at the margin of the Lake, a short distance west of the boat-landing. Flowering specimens of an Elder doubtless referable to this species were seen also at the rim of the crater. Nos. 401 and 370.

VALERIANACEAE. (Valerian Family).

VALERIANA SITCHENSIS, Bong.

Found in moist places on the slopes of Castle Crest. A plant with minutely pubescent foliage supposed to be referable also to this species was seen in somewhat drier situations in the same vicinity. No. 397.

CARDUACEAE. (Aster Family).

EUPATORIUM OCCIDENTALE, Hook.

Reported only by Mr. Gorman from Wizard Island.

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CHRYSOTHAMNUS BLOOMERI, (Gray) Greene.

A shrub abundant everywhere on the pumice slopes, but not yet in flower at the time of our visit.

EUCEPHALUS COVILLEI, Greene.

A branching, erect plant with sessile, ovate-lanceolate leaves tomentose beneath, and commonly 3 to 6-rayed heads. Found only on the shoulder of a small rocky knob a few rods westward from Pole Bridge. No. 327.

ASTER SHASTENSIS, Gray.

A single fragmentary specimen collected by Dr. Merriam on Llao Rock, doubtfully referred to this species.

ERIGERON SALSUGINOSUS, (Richards.) Gray.

A somewhat Aster-like species, commonly 30 cm. (1 ft.) in height; not uncommon along streams and wet meadows.

ERIGERON COMPOSITUS, Pursh.

A low species with narrowly divided leaves; found only on Mount Scott by Mr. Applegate.

ANTENNARIA ALPINA, (L.) Gaertn.

A creeping, matted plant with small, oblanceolate leaves whitened with cobwebby hairs, and erect stems bearing a cluster of small cottony heads with scarious, often lead-colored, involucral bracts. Not uncommon, particularly in rocky soil. No. 431.

ANTENNARIA MARGARITACEA, (L.) Hook. Everlasting.

A tall, cobwebby plant bearing a cyme of small heads with milk-white, scarious involucral bracts. Collected in the woods near the upper camping place. No. 406.

GNAPHALIUM MICROCEPHALUM, Nutt.

Similar to the last, but with smaller heads, the bracts of a dirty white color. Collected in the woods near Pole Bridge. No. 434.

RUDBECKIA OCCIDENTALIS, Nutt.

A tall, coarse perennial bearing one or a few flower-heads with a black disk and no rays. Along the margin of a meadow at the outer base of the crater slope, south of the Watchman, No. 409.

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MADIA BOLANDERI, Gray.

A tall, linear-leaved perennial with glandular-hairy inflorescence and a few flower-heads with black disk and short yellow rays. Found only in the margins of a wet meadow at the outer base of the crater south of the Watchman. No. 414.

ERIOPHYLLUM LANATUM, (Pursh) Forbes.

Similar to *Antennaria alpina* in habit and foliage, but with large, yellow-rayed, yellow-disked flower-heads. Collected on Mount Scott by Mr. Applegate.

HULSEA NANA, Gray.

A low, glandular-hairy plant with pinnatifid leaves and large, single, peduncled, yellow-flowered heads. Collected on a cinder cone northwest of the Watchman and reported also by Mr. Gorman.

RAILLARDELLA ARGENTEA, Gray.

A strongly rooted plant with silvery-hairy, oblanceolate, entire leaves and single, yellow, rayless flower heads on naked scapes. Collected in the same locality as the last. Found also on Mount Scott by Mr. Applegate and on Llao Rock by Dr. Merriam.

ARNICA CHAMISSONIS, Less.

A species with narrow, not cordate leaves, and ray-bearing heads. Frequent in moist soil on rocky slopes. No. 372.

ARNICA CORDIFOLIA, Hook.

A plant with somewhat cordate leaves and very large, raybearing flower-heads, doubtfully referred to this species. Along the trail down the inner slope of the crater. No. 362.

ARNICA LATIFOLIA, Bong.

A species with bright green, cordate, usually glabrous leaves and small ray-bearing heads. Collected on the west slope of Castle Crest. No. 381.

ARNICA PARVIFLORA, Gray.

A rayless species with cordate, canescently pubescent leaves. Collected under trees in dry soil along the trail down to the Lake. No. 365.

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SENECIO TRIANGULARIS, Hook.

A tall, yellow-flowered plant, with smooth, serrate, triangular-lanceolate, petioled leaves truncate or somewhat hastate at the base. Frequent in the margins of meadows. Nos. 421 and 371.

HIERACIUM GRACILE, Hook.

A plant seldom reaching 30 cm. (1 ft.) in height, the bright green foliage smooth or nearly so, the flower-heads yellow, and the involucral bracts clothed with tomentum and short black hairs. Common on rocky, open slopes. Nos. 350 and 359.

HIERACIUM ALBIFLORUM, Hook.

A taller species with pale, hairy foliage and almost white flowers. Common in the forest.

AGOSERIS BARBELLULATUM, Greene.

A small plant closely resembling a dandelion; growing almost everywhere in the pumice fields. No. 375.

Department of Agriculture, Washington, D. C.

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The Mammals of Mount Mazama, Oregon.

C. HART MERRIAM.

The mammal fauna of Mount Mazama is one of more than ordinary interest. In addition to the fact that no list of the mammals of any part of the Cascade Range has ever been published, and that the number of species inhabiting the region is rather large, it is of geographic interest to note that several peculiar west coast types occur here in company with species which do not occur farther west; and that certain northern and southern species find on this mountain, so far as now known, the extreme limits of their ranges. Among the west coast types referred to are the Sewellel (*Aplodontia*), Gibbs' Mole (*Neurotrichus*), the large Water Shrews of the subgenus *Atophyrax*, and Voles of the subgenus *Chilotus*. Besides these, a number of characteristic west coast species—as the Columbia Deer (*Cariacus columbianus*), Oregon Bassarisk (*Bassariscus raptor*), the large gray tree Squirrel (*Sciurus fossor*), Allen's Chipmunk (*Eutamias senex*), and round-tailed Woodrat (*Neotoma fuscipes*)—also inhabit Mount Mazama or the Fort Klamath plain, where they meet or slightly overlap the ranges of species characteristic of the mountains and plateaus farther east. Among the latter are the Rocky Mountain Black-tail Deer (*Cariacus hemionus*), Sierra Marmot (*Arctomys flaviventer*), Pika, or Little Chief Hare (*Ochotona schisticeps*), Golden-mantled Ground Squirrel (*Spermophilus chrysodeirus*), small Chipmunk (*Eutamias amoenus*), Belding's Ground Squirrel (*Spermophilus beldingi*), the sage plains Jackrabbit (*Lepus campestris*), and the Cottontail (*Lepus nuttalli*). A Boreal genus of Voles, *Phenacomys*, not previously known from the Cascade Range south of British Columbia, a Boreal subgenus of Voles (*Arvicola proper**), not previously known from Oregon, the Alpine Flying Squirrel, and several undescribed species were found inhabiting the higher slopes about Crater Lake. Here, also, in

* The animal here referred to is the large Mountain Water Rat, *Microtus* (*Arvicola*) *arvicoloides*.

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the cold streams about Fort Klamath, the two American subgenera of Water Shrews (*Neosorex* and *Atophyrax*) fish and swim in the same pools.

Several mountain mammals of wide distribution are conspicuous by their absence. Thus the Elk or Wapiti (*Cervus canadensis*), Mountain Sheep (*Ovis canadensis*), Mountain Goat (*Oreamnos montanus*), Wolverine (*Gulo luscus*), and Fisher (*Mustela canadensis*) have not been known to inhabit the region in recent years. The Raccoon (*Procyon*) and common small bat of the Pacific coast (*Vespertilio nitidus*) probably occur in the Klamath region but were not obtained by us.

Since the time spent on Mount Mazama and at Fort Klamath by the several members of the Biological Survey collectively was only about a month (Aug. 12—Sept. 15, 1896), it cannot be assumed that all the mammals of the region were secured. Sixty-one species are included in the accompanying list, most of which were obtained in good series, the total number of specimens collected and brought back to our National Museum being about 450.

My assistants who took part in this work were Vernon Bailey, Chief Field Naturalist of the Biological Survey, and Edward A. Preble and Cleveland Allen, assistants. The localities at which collections were made are: Williamson river, near the road crossing; Fort Klamath; Anna Creek Canyon and Pole Bridge Creek; Crater Lake near end of road; Glacier Peak and Llao Rock; Diamond Lake; the upper or western Sink Creek (at the east base of the range on the road from Diamond Lake to Klamath Marsh); and Prospect, in the upper Rogue river valley, on the west slope of Mount Mazama.

In addition to the specimens above mentioned, I had many years previously (in 1883-84) received as a gift from the late Major Charles E. Bendire a small collection made by him at Fort Klamath. This collection contained several new species, of which *Spermophilus chrysodeirus* and *Atophyrax bendirei* were described by me. Subsequently Dr. J. C. Merrill presented me with a few additional specimens, including the chipmunk described as *Tamias amoenus*

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by Dr. J. A. Allen, and still later I purchased others from a soldier named Samuel Parker.

Owing to the chaotic state in which a large proportion of the groups of North American mammals still remain, it has been necessary, in the preparation of the present paper, to make revisionary studies of the greater number of genera inhabiting the northwest coast region, involving the critical examination of several thousand specimens. It has been impossible to complete these studies in time to announce all the results in this list; subsequent work is sure to increase the number of recognized forms — particularly in wide ranging species.

When camped at Crater Lake, Capt. O. C. Applegate, of Klamath Falls kindly brought to my tent two of the principal Indians of the Klamath tribe, and assisted me in obtaining from them a vocabulary of their names for the native mammals; and has since sent me several additional names, thus covering all of the mammals known to these Indians. This has enabled me to give the Klamath names in the present paper. On showing the Indians specimens of the Pika, or Little Chief Hare (*Ochotona*) and Mountain Jumping Mouse (*Zapus*) I was surprised to find that these animals were unknown to them. On the other hand they discriminated between, and had special names for, the small Shrew, White-footed Mouse, and Field Mouse or Vole, as well as for the larger kinds.

LIFE ZONES OF MOUNT MAZAMA.

Mount Mazama, formerly known as Crater Lake Mountain, is in the southern part of the Cascade Range in Oregon, about 20 miles north of old Fort Klamath. It is the basal part of what was once a large volcanic cone, but is now cut off at an altitude of about 2,500 meters (8,200 feet). Its summit is a large caldron, nearly 6 miles in diameter, and 1,220 meters (4,000 feet) in greatest depth. This caldron contains the far-famed Crater Lake, one of the most attractive bits of scenery on the American continent. There is no 'timber-line' on Mount Mazama, although local timber-lines exist on Glacier Peak and one or two other of the higher crags.

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The Watchman. Glacier Peak. Devil's Backbone. Wizard Island. Llao Rock. Mt. Thielsen.

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SOUTHWESTERN SHORE OF CRATER LAKE, LOOKING FROM THE CAMP GROUND.

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The whole mountain, except a small pumice desert north of the Lake and some narrow meadows on its rim, is covered with a dense forest, notable for the size and magnificence of its trees. This forest is made up of a number of species of conifers, arranged in definite belts or zones, corresponding with the three faunal zones—the Hudsonian, Canadian, and Transition—into which the life of the mountain slopes may be divided.

The lower part of Klamath basin, including the treeless area between Klamath Lake and Tule or Modoc Lake, and a strip on the east side of Klamath Lake south of Williamson river, belongs to the Upper Sonoran Zone, and is characterized by such mammals as the Black-tailed Jack Rabbits, Kangaroo Rats, Pocket Mice, Grasshopper Mice and other interesting forms which do not occur at Fort Klamath or on the mountain, and consequently are not mentioned in the accompany list.

The life zones of Mount Mazama, beginning at the bottom, may be characterized and defined as follows:

(1) *The Transition Zone.*—The Transition Zone covers the flat between Upper Klamath Lake and the base of Mount Mazama (thus including the ground formerly occupied by Fort Klamath), and pushes up the south slope to an altitude of about 1,525 meters (5,000 feet), which point is 10 or 12 miles northwest of the old Fort. To the south, it reaches continuously to Williamson river, and covers the hills beyond to within a mile or two of the town of Klamath Falls. To the west, it is believed to extend continuously from the Klamath Lakes to the lower Rogue river valley in southwestern Oregon and Klamath valley in northwestern California.

The characteristic and dominant tree of the Transition Zone is the Yellow Pine (*Pinus ponderosa*) which grows to very large size—single trees measuring upwards of 7 feet in diameter—and covers nearly the whole of the plain north of Williamson river and the south slope of the mountain up to the altitude mentioned. Scattered through this splendid forest are trees of the Incense Cedar (*Libocedrus decurrens*) and the long-coned Sugar Pine (*Pinus lambertiana*). The White Fir (*Abies concolor*), Douglas Spruce (*Pseudotsuga mucronata*), and Aspen (*Populus tremuloides*) also occur here

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and there but belong more properly to the zone above. The most conspicuous undergrowth consists of Manzanita (*Arctostaphylos patula*), Buckbrush (*Ceanothus velutinus*) and *Kunzia tridentata*. A characteristic flower is the handsome *Gilia aggregata*.

Among the characteristic birds of the Transition Zone in the Klamath region are: Lewis' Woodpecker (*Melanerpes torquatus*), the Pigmy Nuthatch (*Sitta pygmaea*), three small Flycatchers (*Contopus richardsoni, Empidonax trailli and E. obscurus*), the Warbling and Cassin's Vireos (*Vireo gilvus swainsoni and V. cassini*), the Magpie (*Pica hudsonica*), Chipping Sparrow (*Spizella socialis arizonae*), Green-tailed Towhee (*Oreospiza chlorura*), Lazuli Finch (*Passerina amoena*), House Wren (*Troglodytes aedon parkmani*) and Western Blue-bird (*Sialia mexicana occidentalis*.)

Few mammals are anywhere distinctive of the Transition Zone, most of its species coming from the zone below (Upper Sonoran) or the zone above (Canadian). Among those which reach their upper limit here are the Gray Fox (*Urocyon*), the Little Spotted Skunk (*Spilogale*), the large gray tree Squirrel (*Sciurus fossor*), Round-tailed Woodrat (*Neotoma fuscipes*), Gray and Oregon Ground Squirrel (*Spermophilus douglasi*), Belding's Ground Squirrel (*Spermophilus beldingi*), the California Vole (*Microtus californicus*), the California Mole (*Scapanus californicus*), the Sage Plains Jackrabbit (*Lepus campestris*), and LeConte's Bat (*Antrozous pallidus*). The Klamath Flying Squirrel (*Sciuropterus klamathensis*) is known only from the pines, but may inhabit the Canadian or lower Boreal also. The black-bellied Water Shrew (*Atophyrax bendirei*) and the Long-tailed Mountain Vole (*Microtus mordax*) inhabit the borders of the cold streams which flow through the Transition plane from the Boreal mountain sides, but probably belong to the Canadian fauna rather than the Transition. The 'Red' or small Pine Squirrel (*Sciurus californicus*) is common to the Transition and Canadian belts, but does not push up into the Hudsonian. Among the species which come down into the pines from the Boreal mountain sides are the Golden-mantled Ground Squirrel (*Spermophilus chrysodeirus*), the large and small Chipmunks (*Eutamias senex* and *E. amoenus*), the Sierra Marmot (*Arctomys flaviventer*) and the Weasel (*Putorius arizonensis*).

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The fauna of the Transition Zone at Prospect in the upper Rogue river valley, at the west base of Mount Mazama, differs in some respects from that of the Klamath plain, which latter has a strong Boreal tinge. Thus *Bassariscus raptor*, *Zapus pacificus* and *Evotomys obscurus* were obtained at Prospect but not at Klamath.

(2) *The Canadian Zone.*—The Canadian Zone occupies the middle elevations of Mount Mazama and sends long tongues downward along the water courses that traverse the Transition Zone below. On the south slope of the mountain it begins about 10 miles northwest of Fort Klamath and covers a broad belt between the altitudes of 1,450 and 1,850 meters (4,800 to 6,100 ft.). The dominant tree is the Lodgepole or Murray Pine (*Pinus murrayana*) a relatively small tree thickly beset with cones and forming a dense continuous forest. Other characteristic species are the Mountain White Pine (*Pinus monticola*), Douglas Spruce (*Pseudotsuga mucronata*) and White Fir (*Abies concolor*), which latter pushes down into the zone below. The Canadian zone shares with the Hudsonian two of the finest trees of the mountain—the Noble Fir (*Abies nobilis*) and Alpine Hemlock (*Tsuga pattonii*). The most conspicuous and offensive underbrush is the Buckbrush (*Ceanothus velutinus*) which forms almost impenetrable thickets and reaches downward through the Transition Zone also. But the Manzanita of the Transition belt (*Arctostaphylos patula*) is replaced in the Canadian by a dwarf species (*A. nevadensis*).

So little field work was done in the Canadian fauna of Mount Mazama that its distinctive birds and mammals cannot be enumerated with certainty. The following birds, however, breed in the Canadian belt of the mountain and may be fairly regarded as belonging to it, though several of them range down well into the pines*. Steller's Jay (*Cyanocitta stelleri*), Williamson's Woodpecker (*Sphyrapicus thyroideus*), Mountain Tanager (*Pyranga ludoviciana*) Olive-sided Flycatcher (*Contopus borealis*), Water Ouzel (*Cinclus mexicanus*), Oregon Junco (*Junco oregonus*), Western Creeper (*Certhia familiaris occidentalis*), Calaveras Warbler (*Helminthophila*

*It must not be inferred that a bird can be classed as Transition because it breeds at Fort Klamath, for the mixture of Canadian trees and conditions along the water courses invites many Boreal species to remain through the summer.

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rubricapilla gutturalis), Pileolated Warbler (*Myiodioctes pusillus pileolatus*). Other species, which are common to the Canadian and Hudsonian Zones, will be mentioned under the latter.

The Canadian Zone mammals which range down to the Klamath plain but were not found in the Hudsonian are the Weasel, Mink, large Skunk, Red or Pine Squirrel, and Snowshoe Rabbit. Those which are common to the Canadian and Hudsonian are the Oregon Puma, Lynx, West-coast Wild-cat, Black Bear, Western Marten, Columbia Black-tail Deer, Porcupine, Jumping Mouse, Long-tailed Vole, Gibbs' Mole, White-bellied Water Shrew, Sierra Shrew, and Silver-haired Bat.

(3) *The Hudsonian Zone.*—The Hudsonian Zone occupies the summit of the mountain and descends on the south side to an altitude of about 1,850 meters (6,100 ft.) which is only a short distance above Pole Bridge Creek. The dominant trees are Alpine Hemlock (*Tsuga pattonii*) and the Noble Fir (*Abies nobilis*). Mixed with these are numerous Alpine Firs (*Abies lasiocarpa*) and a few White-bark Pines (*Pinus Albicaulis*). The latter are confined mostly to the rim of Crater Lake and are therefore of no value in fixing the lower boundary of the zone. The Hudsonian belt is characterized by negative as well as positive elements, lacking the Lodgepole Pine (*Pinus murrayana*), Mountain White Pine (*Pinus monticola*) and White Fir (*Abies concolor*) of the Canadian Zone.

The following Boreal species of bird breed about Crater Lake in the Hudsonian Zone and many of them occur also in the Canadian: Oregon Jay (*Perisoreus obscurus*), Clark's Crow or Nutcracker (*Nucifraga columbiana*), Evening Grosbeak (*Coccothraustes vespertinus*), Cassin's Purple Finch (*Carpodacus cassini*), Crossbill (*Loxia curvirostra stricklandi*), Pine Siskin (*Spinus pinus*), Townsend's Solitaire (*Myadestes townsendi*), Three-toed Woodpecker (*Picoides arcticus*), Mountain Bluebird (*Sialia arctica*), Audubon's Warbler (*Dendroica auduboni*) and the Mountain Chickadee (*Parus gambeli*).

The distinctive mammals of the Hudsonian summit of Mount Mazama are the Alpine Flying Squirrel (*Sciuropterus alpinus*), the Alpine Mole (*Scapanus Alpinus*), the Giant Mole or Water Rat

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(*Microtus arvicoloides*), the alpine *Phenacomys orophilus*, the Mount Mazama Red-backed Mouse (*Evotomys mazama*), Baird's Alpine Vole (*Microtus bairdi*) and the Sierra Pika, or Little Chief Hare (*Ochotona schisticeps*). The Sierra Sewellel (*Aplodontia major*) occurs locally. A number of other species which are more or less common on top of the mountain, range down through the Canadian Zone, under which head they have already been enumerated.

The boundaries between the zones are marked by belts of overlapping, where the trees of the zone below mix with those of the zone above over a belt covering a vertical difference in altitude of about 125 meters. The actual breadth varies according to the slope, being less than a quarter of a mile on very steep slopes and a mile or more on gradual slopes.

The Yellow Pine forest of the Transition plain between the north end of Klamath Lake and the south base of the mountain is interrupted in a number of places by trees which come down from the Canadian belt above. These trees are chiefly Lodgepole Pines, more or less mixed with Douglas Spruces and White Firs. It will be observed that they follow the cold streams and cover the flat swampy lands where the temperature is much lower than in the pine forest. Birds and mammals of the Canadian Zone inhabit these places as will be shown later.

THE FORT KLAMATH PLAIN.—The site of Fort Klamath, now abandoned, will always be a place of special interest to naturalists, on account of the large collections in different branches of natural history made there by Captain (afterwards Major) Charles E. Bendire and Dr. J. C. Merrill.* It is moreover the type locality of a number of species, for which reason its faunal relations should be clearly understood. From the preceding description, it will be evident that while the post itself is in the Transition Zone, a day's ride to the south enables the collector to obtain Upper Sonoran species, and a day's ride to the north or west takes him into the mountains where he is surrounded by Canadian and Hudsonian species.

*A very full and valuable list of the Birds of Fort Klamath, with critical notes by William Brewster, was published in the *Auk* for 1888 by Dr. J. C. Merrill. An earlier and less complete list had been published by Dr. E. A. Mearns.

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Fort Klamath itself is in the midst of a forest of magnificent Yellow Pines, which covers the greater part of an extensive area of flat ground between the tule marshes at the north end of Klamath Lake and the base of the Cascade Range. The altitude of this flat is about 1,280 meters (4,200 ft.), and it is in the upper part of the Transition Zone. The pine forest is interrupted by hot pumice meadows and cold Boreal swamps. Several gigantic springs of exceedingly cold water from the mountains break out of the ground and flow away to the lake in large streams (Fort Creek, Wood river and others), carrying lines of Boreal species through the Transition plane. Thus these streams, and the adjacent cold, swampy flats, support small forests of Lodgepole Pines, scattered clumps of Aspens, and a number of bushes and flowers belonging to the Canadian Zone above. To the same influences should be attributed the infusion of Boreal birds in the pines of the Fort Klamath plain, and the presence along the cold streams and swamps of such Boreal mammals as the small Shrew (*Sorex vagrans*), the large Water Shrews (*Atrophyrax bendirei* and *Neosorex navigator*), the Mountain Jumping Mouse (*Zapus trinotatus montanus*), and the Long-tailed Mountain Vole (*Microtus mordax*).

The road from Fort Klamath to Crater Lake follows the south slope of the mountain, and affords a direct and easy grade without the complications that usually result from canyon or gorge slopes on mountain roads. The soil is mainly pumice sand, very fine and very dusty. Anna Creek Canyon, with nearly vertical walls of volcanic tuff, lies close to the road on the east side, and carries Boreal species down considerably below the altitudes they reach on the adjacent slopes.

CRATER LAKE, OREGON. — Crater Lake is a body of clear indigo-blue water, about five miles in average diameter and 600 meters (2,000 ft.) in greatest depth. It occupies the crater of the extinct volcano of Mount Mazama, and is completely encircled by a continuous wall of cliffs varying in height from a little less than 300 to a little more than 600 meters (1,000-2,000 ft.). There is no break in this wall, which is so nearly perpendicular that climbing up or down is impossible, save in

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a few places. Large masses of snow remain all summer on the north and east slopes, and small streams, turned up on end, dash down some of the gulches from the melting snowbanks above. Dark coniferous trees, chiefly Hemlocks and Noble Firs, have here and there gained a foothold on the steep slopes, and afford pleasing contrasts with the sombre gray of the crater. Wizard Island, a remarkably perfect cinder cone rising 260 meters (850 ft.) above the water on the west side of the Lake, has a perfect crater on its summit, and is fairly well covered with trees — Hemlocks, Noble Firs, White Pines and Alpine Firs. A colony of Pikas (*Ochotona*), of which I shot one, and a Ground Squirrel — probably *Spermophilus chrysodierus* — seen by Mr. Coville and others, inhabit the Island. The Island is separated from the rim on the west by a narrow and shallow channel about a quarter of a mile in breadth, over which the mammals doubtless crossed on the ice in early spring. At the Island I shot two Mallard Ducks, and saw a Golden-eye and some Grebes—apparently *Podilymbus podiceps*. A few Tip-ups (*Actitis macularia*) and a Water Ouzel (*Cinclus mexicanus*) were also seen along the rocky shore. Although there are no fish in the Lake, amphipod crustacea and caddice fly larvæ abound, and millions of black mosquitos, with black, fuzzy antennæ, swarmed along the shore; being males, these mosquitoes did not bite, which was refreshing.

On the rim of Crater Lake, cliffs and crags alternate with narrow fields of pumice, which latter are buried in snow until late in the summer.

A few mammals live on the inner or lake side of the crater. Shrews and Voles inhabit the narrow strips of vegetation bordering the springs and streams; Chipmunks enliven the scattered clumps of trees; and Pikas, Marmots, and Golden-mantled Ground Squirrels make their homes among the heaps of slide rock on the steep slopes.

The Hemlock Forest.—The whole summit of the mountain except the pumice meadows on the rim, is covered by a noble forest of Hemlocks and Firs. The dominant tree is the large black-barked Alpine Hemlock (*Tsuga pattonii*) whose trunks sometimes attain great size—the largest found by us measuring 1¾ meters (69 inches)

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in diameter at the height of a man's head. These trees often grow in clusters, half a dozen or more standing side by side, sometimes in a straight line, and so close together that the trunks are in actual contact at the bottom. On sloping ground the trunks are often curved downward at the base, from the pressure of the snow which covers the ground for 9 months of the year. The Alpine Hemlock, with its irregularly drooping branches, draped in long beards of gray and black lichen, is a beautiful and picturesque tree. The widely different Noble Fir with which it is associated, is also a large and splendid tree. Owing to the relative shortness of its lower branches its usual form is cylindrical rather than conical. The branchlets, particularly the upper ones, stand out at right angles, giving an odd mathematical effect; but the crowning glory of *Abies nobilis* lies in its huge cones, with their leaf-like exserted green bracts, ivory white scales, and blood red seed-wings.

The hemlock forest is dark and open, with very little undergrowth, chiefly *Vaccinium myrtilloides*, *V. scoparium* and *Rubus lasiococcus*, with here and there scattered plants of *Pyrola picta*, *Chimaphila menziesii*, *C. umbellata*, and *Pedicularis racemosa*. It is the home of the Camp Robber or Oregon Jay, the Evening Grosbeak, Red Crossbill, Pine Siskin, Three-toed Woodpecker, and Townsend's Solitaire; of the Alpine Flying Squirrel, Allen's Chipmunk, Western Marten, Columbia Deer, Lynx, and Oregon Puma.

The Pumice Meadows.—The open pumice meadows of the rim of Crater Lake deserve a special word. Most of them are buried in snow until August and many of the snowbanks never entirely disappear. As soon as the bare ground is exposed to the warm sun it becomes dotted over with small plants which increase in abundance as the season advances, and furnish an important part of the food of certain small mammals. The most characteristic plants of these pumice meadows are *Polygonum newberryi*, *Phlox douglasii*, *Aplopappus bloomeri*, *Spraguea umbellata*, *Agoseris barbulata*, *Lupinus laxiflorus*, *Antennaria alpina*, a small *Arenaria*, and two or three species of Eriogonum*. These places are the chosen homes of

*I am indebted to Mr. F. V. Coville for the specific determinations of these plants.

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the Pocket Gophers (*Thomomys mazama*) which are constantly turning the soil and throwing up little mounds of damp earth by which their movements may be known. They are inhabited also by the White-footed Mice and Baird's Alpine Vole.

The Springs and Small Marshes.—The springs and wet places in the immediate vicinity of Crater Lake support a luxuriant growth of alders, wild currants and other bushes and small plants, among which are *Spiraea arbuscula*, *Kalmia glauca*, *Lonicera involucrata*, *Veratrum viride*, *Mimulus lewisii* and *M. luteus*, *Aquilegia formosa*, *Dicentra formosa*, *Pedicularis groenlandica*, *Pyrola secunda*, *Ranunculus eschscholtzii* and *Veronica alpina*.

These places are the homes of the Alpine Water-rat (*Microtus arvicoloides*), Red-backed Mouse (*Evotomys mazama*), Mountain Jumping Mouse (*Zapus trinotatius*), Alpine Mole (*Scapanus alpinus*), Gibbs' Mole (*Neurotrichus gibbsi*), Water Shrew (*Neosorex navigator*) and Sierra Shrew (*Sorex vagrans amoenus*).

The Cliffs.—The cliffs on the rim of Crater Lake are adorned here and there by scattered hemlocks and firs and are dotted by little clumps of flowering bushes, of which *Spiraea discolor*, *Pentstemon davidsoni* and *P. newberryi* are the most abundant. A small woody *Polygonum* (*P. shastense*) and one or two Eriogonums are also common. These cliffs are the homes or favorite resorts of the Sierra Marmot, Pika, Golden-mantled Ground Squirrel, Small Chipmunk, Badger, Yellow Fox, Bushy-tailed Wood-rat and White-footed Mouse.

CATALOGUE OF SPECIES.

COLUMBIA BLACK-TAIL DEER. *Cariacus Columbianus* (*Richardson*).

Klamath Indian name, *moos-mus*.

Abundant. Fresh tracks were seen every day and many deer were killed during our stay. Our party killed three, one within a few rods of camp at Crater Lake; two others in the forest below the base of Glacier Peak. As a rule the deer were quiet during the greater part of the day, and started out to feed about the middle of

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the afternoon. The bucks were active and pawed many holes in the dry ground.

The Rocky Mountain Black-tail or Mule Deer (*Cariacus hemionus*) is said to find the western limit of its range along the east base of the Cascades, and the White-tail Deer is said to be found sparingly about the base of the mountain.

ANTELOPE. *Antilocapra Americana*, Ord.

Klamath Indian Name, *Cha-o.*

Antelope are still fairly common on the plains and deserts east of the Cascade Range and on Klamath Marsh, where they are said to be much hunted by the Indians. In summer small bands of Antelope push through the forest of Lodgepole Pines at the east base of the Cascades to the narrow meadows along the upper Des Chutes river. On August 27, 1896, Mr. Bailey and I saw a small herd at the crossing at East Fork of Des Chutes, in dense forest; and the next day we saw others in the small 'prairie' on Paulina Creek. During our stay at Crater Lake we were told that Antelope were seen on the pumice desert between Crater Lake and Diamond Lake.

ALPINE FLYING SQUIRREL. *Sciuropterus Alpinus* (Richardson).

Klamath Indian name, *Kok-kotch.*

A specimen of this Hudsonian species was caught at Crater Lake by Mr. Preble. It was taken in a trap set at the base of a stub in open woods about a quarter of a mile from the crater.

KLAMATH FLYING SQUIRREL. *Sciuropterus Klamathensis*, Merriam.

Klamath Indian name, *Kok-kotch.*

Two specimens of this new species of Flying Squirrel were sent me from Fort Klamath some years ago by the late Major Charles Bendire. They were caught in a hollow log May 15, 1883. Whether or not the species ranges above the Transition Zone was not determined.

PINE SQUIRREL. *Sciurus Californicus*, Allen.

Klamath Indian name, *Go-wack.*

Common in the Transition and Canadian Zones from Fort Klamath half way up the mountain. Two were seen at Pole Creek,

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at the upper edge of the Canadian Zone (alt. 5,800 ft., or 1,760 meters) by Mr. Cleveland Allen. They were rather common at Prospect, but were not found anywhere in the Hudsonian belt and consequently were absent from the immediate vicinity of Crater Lake.

OREGON GRAY SQUIRREL. *Sciurus fossor*, Peale.

This large gray tree squirrel ascends the Rogue river valley to Prospect, where it was found by Mr. Preble. It occurs also in the Yellow Pine forest on the east side of Klamath Lake, along the road between Klamath Falls and Williamson river.

ALLEN'S CHIPMUNK. *Eutamias senex*, Bachman.

Klamath Indian name *Was-la.*

This large dark-colored chipmunk occurs on most parts of the mountain, though its distribution seems to be somewhat irregular; at all events it is decidedly rare at some points and common at others. It was found along the east base of the mountain among the firs and Lodge-pole Pines, whence it ranges northward to Farewell Bend on the Des Chutes river. It occurs also at Fort Klamath, and in the upper Rogue river valley at Prospect, where it was common. At Crater Lake it is common in the dark hemlock forest, but is rather silent and shy and consequently less often seen than its smaller relative, *E. amœnus*, who is always in evidence. Townsend's Chipmunk climbs the giant hemlocks fearlessly and feeds on the seeds of their cones, scattering the scales about its quarters. It makes a low chucking noise similar to that made by the red or pine squirrel, and also suggesting the note of the eastern Chipmunk, *Tamias striatus*.

MOUNTAIN CHIPMUNK. *Eutamias amœnus*, Allen.

Klamath Indian name *Was-la.*

This small chipmunk is common from the lower edge of the Yellow Pine forest about Klamath Lake all the way up to Crater Lake on the summit of the mountain. It is most common in open places in the woods and in bare spots among logs, stumps and rocks, but is also found in the forest, and a few were caught at Fort Klamath in traps set for shrews and meadow mice in thick grass on the river banks. Near Klamath Lake it was found outside of the

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pine woods among the mountain mahogany and chaparral. Unlike the large Townsend's Chipmunk, it is always in sight and rarely if ever climbs trees. On the west or Rogue river side of the mountain, Mr. Preble did not find it below Union Creek, about 16 miles from Crater Lake, and thinks this marks its lower limit on that slope.

LARGE GRAY GROUND SQUIRREL. *Spermophilus douglasi*, Richardson.

Klamath Indian name, *Cho-chuck.*

Common in the lava rock of the Transition Zone on the east side of Klamath Lake, and at Prospect in the upper Rogue river valley. It does not enter the Canadian or Boreal Zone, and consequently is found about the base of the mountain only.

BELDING'S GROUND SQUIRREL. *Spermophilus beldingi*, Merriam.

Klamath Indian name, *Me-sas.*

This short-tailed brownish ground squirrel is very abundant at Fort Klamath, where it lives in the pumice meadows and also in the more open parts of the pine forest immediately about the post.

GOLDEN-MANTLED SPERMOPHILE. *Spermophilus chrysodeirus*, Merriam.

Klamath Indian name, *Chihl-lass.*

Abundant everywhere about Crater Lake, on the summit of the mountain, and also in the Yellow Pine belt about Fort Klamath. On the rim of Crater Lake families were found in many places living in the rock slides with the Pikas (*Ochotona*). On the west slope Mr. Preble found them in the upper Rogue river valley 15 or 20 miles below Crater Lake. Mr. Preble caught a young one on Anna Creek the first week in September, and took it down to Fort Klamath, where he left it ten days later "in contented possession of a burrow it had appropriated." This little one became quite tame, and ate oatmeal, bread and fruit.

GROUND HOG; SIERRA MARMOT. *Arctomys flaviventer*, Audubon & Bachman.

Klamath Indian name, *Mo-e.*

This large Marmot is abundant among rocks on the side of Castle Crest, and was seen at various other points along the rim of

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Crater Lake, all the way round to Llao Rock. It occurs also on the lava beds near Fort Klamath.

MOUNTAIN SEWELLEL. *Aplodontia major*, Merriam.

This curious animal, which looks like a bobtailed muskrat, occurs locally on Mount Mazama. Mr. Preble found a large colony in the canyon of Anna Creek, about half a mile from Pole Bridge Creek bridge. Their burrows and runways were mostly in low willow thickets immediately bordering the creek, but some were in thick rank grass near the edges of the willows. Many of the burrows and runways seemed to be in use, but the animals were difficult to trap, and only three specimens were taken. Considerable quantities of hay, consisting mainly of grass, lupine, and stems of willows, were piled up to dry near the mouths of the burrows and on bushes and logs in the immediate neighborhood. This hay was found in small bunches with the butt ends close together, evidently just as carried in the amimal's mouth. Several other colonies were heard of, one in the upper Rogue river valley, another near the head of Sun Creek.

BEAVER. *Castor canadensis*, Kuhl.

Klamath Indian name, *Pome*.

Beaver are now scarce on Mount Mazama. Old signs are plentiful along a stream flowing into Diamond Lake, and a few trees were found there that had been recently gnawed. In the neighborhood of Fort Klamath numerous signs of former presence were seen, and along Wood river many alders and other bushes that had been cut down by them.

EUROPEAN HOUSE MOUSE. *Mus musuclus*, Linn.

Some years ago a specimen of the common House Mouse was sent me from Fort Klamath by the post surgeon, Dr. J. C. Merrill. It was captured in 1886, and is of interest as showing that the species had penetrated to Fort Klamath before this date—perhaps many years before. Dr. Merrill tells me that it was common at the post during his stay.

WHITE-FOOTED MOUSE. *Peromyscus leucopus gambeli*, (Baird).

Klamath Indian name, *Me-ko-ka*.

White-footed Mice, while universally distributed over the moun-

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tain, are less common than in most parts of the country. At Crater Lake a few were caught in the pumice sand along the rim, others among the cliffs, and still others among rocks in the woods. It is possible that two species exist at Crater Lake, since the specimens collected show a very large range of variation. At Fort Klamath White-footed Mice are more common and a number of specimens were collected.

PACK RAT; BRUSH-TAILED WOODRAT. *Neotoma cinerea*, Ord.

Klamath Indian name, *Cho-cho*.

Common in places throughout the region. One was trapped by Mr. Bailey on Castle Crest, on the rim of Crater Lake, at an altitude of 8,000 ft. (2,438 meters); and others were obtained by Mr. Preble at Prospect in the upper Rogue river valley, at Fort Klamath, and in the lava ledges on the east side of Klamath Lake. Some of their nests examined by Mr. Preble contained bones and skulls. One had apparently been made near the spot where an Indian had been buried, for most of the skeleton was found in the nest. In this same nest were remains of spermophiles, skunks, dogs, coyotes, fishes, and so on. The Bushy-tailed Woodrat is evidently somewhat carnivorous, although I am not aware that this fact has been previously recorded. A nest found by me in a hollow juniper between Goose Lake and the Modoc lava beds, contained two young rats and a dead pocket gopher. The latter had been recently killed and was partly eaten. It had evidently been captured and taken to the nest by the parent rat.

ROUND-TAILED WOODRAT. *Neotoma fuscipes*, Baird.

This Round-tailed Woodrat is common in in Rogue river valley and is said to occur also at Pelican Bay on Upper Klamath Lake.

ALPINE PHENACOMYS. *Phenacomys orophilus*, Merriam.

During our stay at Crater Lake a special effort was made to secure speciment of this genus, and hundreds of traps were kept set in likely places. All our efforts proved fruitless however until the morning of August 22, when Mr. Preble found a specimen in one of his traps on the steep west slope of Castle Crest. It was in a dry place among low huckleberry bushes near a rock cliff, at an altitude

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of about 7,800 ft. (2,375 meters). A few days latter, when we had moved camp to the northwest part of the rim, Mr. Bailey caught one at the north base of Glacier Peak. At Diamond Lake Mr. Preble secured another specimen in a trap set in thick grass at the south end of the lake.

Since the type specimen of *Phenacomys orophilus* was obtained by Mr. Bailey and myself in the Salmon River Mountains of Idaho, in 1890, additional specimens have been secured in the Saw Tooth Mountains, Idaho; Bear Tooth Mountains and Mary's Lake region, Montana; Yellowstone National Park, Wyoming; the Blue Mountains and Cascade Range, Oregon. In the Cascades we obtained specimens, during the past season, at Mount Hood, Diamond Lake and Crater Lake, showing that the animal inhabits suitable spots at high altitudes all along the range.

MOUNT MAZAMA RED-BACKED MOUSE. *Evotomys mazama*, Merriam.

This new species is common in the Hudsonian Zone at Crater Lake, where a number were caught in traps set among logs, both in the dark hemlock forest and in the thick growth of plants near the small cold streams. The species seems to be partly arboreal and somewhat diurnal, as usual in this genus. I saw one crawl along on the loosened bark of a log in broad daylight, and saw another jump down from a dead tree, but could not be certain whether it was outside of the bark or had come out from beneath a large scale of loose bark. Mr. Preble saw one in the spruce woods near the head of Anna Creek, where several were secured.

SHORT-NOSED RED-BACKED MOUSE. *Evotomys obscurus*, Merriam.

This is another new species. It is based on specimens collected at Prospect by Mr. Preble. One was caught in a damp mossy place near Rogue river Falls, the others in grassy places near the river. A single specimen was secured by Mr. Bailey on the west slope of Mount Mazama below Glacier Peak. The animal is considerably darker than *E. mazama*.

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LONG-TAILED VOLE. *Microtus mordax*, Merriam.

This long-tailed vole is a mountain or Boreal animal and is rather common on the steep west slope of Castle Crest on the rim of Crater Lake, where it occurs both in springy places and in drier situations. Like the large vole it makes runways and holes, and cuts much grass and other small plants. It was obtained by Mr. Preble at Diamond and Paulina Lakes, and by Mr. Bailey and myself on West Sink Creek and the upper Des Chutes river. On Mount Mazama it follows the cold streams down to Fort Klamath where it is common in the thick grass and bushes bordering Wood river and Fort Creek.

COMMON VOLE. *Microtus californicus*, Peale.

Klamath Indian name, *Gli-wa.*

The California Vole seems to be restricted to the Transition Zone and consequently does not occur on the mountain. It is common at Fort Klamath where it was found chiefly in the hay fields.

GIANT VOLE. *Microtus* (*Arvicola*) *arvicoloides*, (Rhoads).

Klamath Indian name, *Gli wa.*

This, the largest of the Voles of Mount Mazama, is common in a variety of places within the Hudsonian Zone, but always in damp or moist situations. Numerous specimens were obtained at Crater Lake and along the upper part of Anna Creek, near Pole Creek. At the latter locality two were caught in steel traps set in runways of the Sewellel (*Aplodontia*). This species is partly aquatic and is abundant along little spring streams where it makes large runways of its own in very wet places, and cuts much grass and many succulent water plants, leaving the cuttings scattered about its runways. It has large side glands which secrete a musky odor. Many young were caught ranging from a quarter to three-quarters grown. One of the old females contained 7 embryos.

BAIRD'S VOLE. *Microtus* (*Chilotus*) *bairdi*, Merriam.

This new species was caught by Mr. Bailey at the north base of Glacier Peak, on the rim of Crater Lake, where it was living in burrows in open grassy places on the pumice sand. It is interesting as being the second species described of the subgenus *Chilotus*—a

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subgenus established by Professor Baird, for whom the present species is named.

POCKET GOPHER. *Thomomys mazama*, Merriam.

Klamath Indian name, *Mo-nana-tam-has*.

Abundant throughout the region. Common in the pumice meadows on Llao Rock and at numerous other places on the rim of Crater Lake where its little hills were thrown up every day; also common at Fort Klamath.

MOUNTAIN JUMPING MOUSE. *Zapus trinotatus montanus*, Merriam.

Abundant in moist places grown over with grass or weeds. Specimens were secured at Crater Lake, Anna Creek Canyon, and Fort Klamath.

PACIFIC JUMPING MOUSE. *Zapus pacificus*, Merriam.

This new species, which is smaller and yellower than the mountain animal, was collected by Mr. Preble in the upper Rogue river valley at Prospect.

PORCUPINE. *Erethizon epixanthus*, Brandt.

Rather common. Mr. Bailey saw fresh tracks several times near the spring at the head of Anna Creek, about ¼ mile from the rim of Crater Lake. In the forest of Lodge-pole Pines (*Pinus murrayana*) between Crater Lake and Mt. Thielsen, 'barked' trees abound.

PIKA; MOUNTAIN CONEY; LITTLE CHIEF HARE. *Ochotona schisticeps*, Merriam.

Abundant at Crater Lake, where numerous specimens were collected. The Pika makes its home in the precipitous rocky slopes of the lake rim, both on the outer and inner side, living among the loose slide rock and laying up little stores of plants for winter use. A small colony was found on Wizard Island in the Lake, where I shot and secured a specimen. Small colonies follow the canyon of Anna Creek down to an altitude of about 1,830 meters (6,000 ft.).

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SNOWSHOE RABBIT. *Lepus washingtoni*, Baird.
Klamath Indian name, *Chi.*

Tolerably common, but exceedingly difficult to procure in summer. Tracks were seen among the thick clumps of young evergreens about Crater Lake. Some years ago a number of specimens, killed near Fort Klamath, were sent me by Major Bendire.

NORTHERN JACK RABBIT. *Lepus campestris*, Bachman.
Klamath Indian name, *Chi.*

Moderately common in the openings and plains about the base of the mountain. A specimen sent me by Major Bendire, killed near Fort Klamath, November 15, 1882, is in the change from the grayish-brown coat of summer to the white coat of winter.

PUMA; MOUNTAIN LION; PANTHER. *Felis hippolestes olympus*, Merriam.
Klamath Indian name, *Dos-lotch.*

Pumas or Mountain Lions are still plentiful in Oregon. In going from our first camp on the southwest side of the rim of Crater Lake to Glacier Peak, Mr. Bailey and I observed the tracks of two Pumas, which we crossed several times in the dense hemlock forest. They were traveling together and were evidently hunting deer.

CANADA LYNX. *Lynx canadensis*, (Geoff.)

The Lynx, which is a more Boreal animal than the Wild Cat, inhabits the higher mountains, and sometimes ranges down into the foothills. It was not obtained by us, but Mr. Elmer J. Applegate of Swan Valley, near Klamath Falls, writes me that his father and brother have both killed Lynxes as well as Wild Cats in this region. It seems safe to assume that the species is the same as that of Mount Adams in the Cascade Range just north of the Columbia.

WILD CAT. *Lynx fasciatus*, Raf.
Klamath Indian name, *Wol-kot-ska.*

Tracks were seen by Mr. Bailey near Crater Lake, but no specimens were obtained.

GRAY WOLF; TIMBER WOLF. *Canis griseus*, Sabine.
Klamath Indian name, *Kow-a-chis.*

Formerly common, but now extremely rare in the southern Cascade region and not met with by our parties.

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COYOTE. *Canis lestes*, Merriam.

Klamath Indian name, *Quatox*, *Ko-la-a*, *Was*.

Coyotes occur on the mountain, but are not common. A few tracks were seen about the brink of Crater Lake. Mr. Preble secured a handsome specimen on Lost river late in September.

BAIRD'S YELLOW FOX. *Vulpes macrourus*, Baird.

Klamath Indian name, *Wan-na*.

Tolerably common. At the time of our visit a family of these foxes had its den on Castle Crest, and another family on the rim of the Lake near the peak known as the Watchman. In fall and winter they doubtless come down to lower altitudes. About the middle of September Mr. Preble saw one near Fort Klamath.

GRAY FOX. *Urocyon californicus*, Mearns?

Klamath Indian name, *Sketch-loo-is*.

No specimens of the Gray Fox were seen by us, but Mr. Burton L. Cunningham told me that the species occurs at Fort Klamath.

GRIZZLY BEAR. *Ursus horribilis*, Ord.

Klamath Indian name, *Lok*.

The Grizzly is now exceedingly rare in the southern Cascades, where it was formerly common and destructive to stock. The last one seen in the Klamath region was killed in the upper part of Wood river valley, near Fort Klamath, in 1894 or 1895. It had killed a number of cattle and calves belonging to a Mr. Vaugn, who has a ranch near Anna Creek, and who shot it with a set gun. For this information I am indebted to Capt. O. C. Applegate and Mr. Burton L. Cunningham.

Respecting the former range of the Grizzly in western Oregon, Capt. Applegate writes me: "On the west side of the Cascades very few Grizzlies have been known to stray north beyond the Umpqua Mountains, and none beyond the Calapooia Mountains. East of the Cascades they ranged as far north as Crooked river not many years ago."

BLACK BEAR. *Ursus americanus*, Pallas.

Klamath Indian name, *We-tam*.

Apparently not common. On August 25, Mr. Bailey and I

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saw fresh tracks among the Lodge-pole Pines between Crater Lake and Mount Thielsen. Some years ago a Black Bear was killed in a tree close by the spring at the head of Anna Creek, less than a quarter of a mile from the rim of Crater Lake, by Captain O. C Applegate.

RACCOON. *Procyon lotor*, Linn.

The Raccoon was not secured by us, but Mr. Burton L. Cunningham informs me that it occurs in the neighborhood of Fort Klamath, where it is not common.

OREGON BASSARISK. *Bassariscus astutus raptor*, Baird.

One of the unexpected captures was a specimen of this handsome species which Mr. Preble secured at Prospect. It was caught in a steel strap at the foot of a tree near a ledge on Rogue river. On account of its long, ringed tail the Bassarisk is locally called "Ring-tailed Cat" and "Coon-tailed Fox." It is also known as the "American Civet," but is not related to the true Civets, none of which occurs in America.

OTTER. *Lutra hudsonica*, Lacepede.

Klamath Indian name, *Kolta*.

Otters are said to occur along Lost river and the streams about Fort Klamath, and Mr. Preble found evidences of their presence at Diamond Lake.

BADGER. *Taxidea americana*, (Boddært).

Klamath Indian name, *Koltz*.

Apparently common throughout the region. Their signs were seen on Castle Crest, near Anna Creek, and also near Diamond Lake.

LARGE SKUNK. *Mephitis occidentalis*, Baird.

Klamath Indian name, *Chaw-sis*.

Tolerably common in the pine forest at Fort Klamath, Prospect, and other points about the mountain, though no signs were observed at the summit. Mr. Preble saw the remains of a dead one at Diamond Lake.

LITTLE SPOTTED SKUNK. *Spilogale phenax latifrons*, Merriam.

At Prospect, in the upper Rogue river valley, Mr. Preble was

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told that a little spotted skunk was killed there sometime previously. Prospect is probably at the upper limit of the species' range.

PACIFIC MINK. *Lutreola vison energumenos*, Bangs.

Klamath Indian name, *Kla-pa*.

Common along the larger streams. We found Mink sign plentiful on the Upper or West Sink Creek, near the northeast base of Mount Mazama; and Mr. Preble secured a specimen at Paulina Lake, some distance farther north.

MOUNTAIN WEASEL. *Putorius arizonensis*, Mearns.

Klamath Indian name, *Ketch-ketch*.

We did not succeed in finding Weasels immediately at Crater Lake, but Mr. Preble caught a pair in runways of the Sewellel (*Aplodontia*) near Anna Creek, about 4½ miles below the rim of the Lake, and at altitude of about 1,830 meters (6,000 ft.). Some years ago Major Charles E. Bendire sent me a pair from Fort Klamath.

PUGET SOUND WEASEL. *Putorius streatori*, Merriam.

This Weasel was not obtained by us, but a rough skin in white winter pelage has been sent me by Mr. Burton L. Cunningham of Fort Klamath, who states that it was killed there by a dog.

PACIFIC MARTEN. *Mustela caurina*, Merriam.

Klamath Indian name, *Pap*.

Common in the hemlock forest immediately about Crater Lake, where three were caught by Mr. Bailey. The stomachs of these specimens were full of large brown crickets.

CALIFORNIA MOLE. *Scapanus californicus*, (Ayres).

Klamath Indian Name, *To-ma-lok*.

This Mole is tolerably common in the Transition Zone flat about Fort Klamath, from which locality Major Bendire sent me four specimens some years ago. It its considerably smaller than *S. alpina*, the new species from Crater Lake.

ALPINE MOLE. *Scapanus alpinus*, Merriam.

Klamath Indian name, *To-ma-lok*.

This fine large Mole is common about the rim of Crater Lake,

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where Mr. Bailey caught the type specimen. Pocket Gophers abound in the same locality and one was caught in the same runway with the Mole.

At Union Creek, about 15 miles west of Crater Lake and at a considerably lower altitude, Mr. Preble found where a Mole had burrowed into a decayed log from below, and had penetrated the log back and forth in search of insects, pushing out the chips on one side.

GIBBS' MOLE. *Neurotrichus gibbsi*, (Baird).

Tolerably common, but difficult to trap. Specimens were obtained at Crater Lake near the head of Anna Creek, on Anna Creek, near Pole Bridge Creek, and at Fort Klamath. They were secured in a variety of situations. At Crater Lake one was caught in a runway in a damp grassy place among small bushes on a steep hillside. At Anna Creek one was caught under a log in a dry place, in a trap baited with meat. At Fort Klamath four were caught in a patch of willows and alders on the bank of Wood river, in traps baited with bacon.

SMALL SHREW; SIERRA SHREW. *Sorex vagrans amœnus*, Merriam.

Klamath Indian name, *Show-sy*.

The common Shrew of the mountain belongs to the *vagrans* group and is so closely related to the Sierra form, described under the name *amœnus*, that it is placed under this head. It is abundant over most parts of the mountain, chiefly in wet springy places. A few were caught under logs in the woods. Specimens were obtained at Crater Lake, Anna Creek, and Diamond Lake. Specimens from Fort Klamath seem to be intermediate between *vagrans* (the coast form) and *amœnus* (the mountain form). They were very abundant along Wood river near Fort Klamath, where about 20 were caught in traps baited with bacon.

BENDIRE'S WATER SHREW. *Sorex* (*Atophyrax*) *bendirei*, Merriam.

The type specimen of this species was obtained by the late Major Charles E. Bendire on Williamson river a few miles south of Fort Klamath. Mr. Bailey secured a second specimen on Fort Creek, close to the old post. It is probably common in the streams of the

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region and may be easily distinguished from the Water Shrew by its black belly.

ALPINE WATER SHREW. *Sorex* (*Neosorex*) *navigator*, Baird.

Common about the little springs and rapid mountain streams. Several were secured at Crater Lake, and along the upper part of Anna Creek, from its source down to Pole Creek. One was taken as low down as Fort Creek, near Fort Klamath, by Mr. Preble. All were caught at the very edge of the water, some in woods, others in marshes. One Mr. Bailey caught alive did not attempt to bite. The species may be distinguished from Bendire's Water Shrew at a glance by its white belly.

BIG-FOOTED BAT. *Vespertilio yumanensis*, H. Allen.

Klamath Indian name, *En-che-cha*.

A small bat of the genus *Vespertilio* sent me from Fort Klamath in 1883 by Major Bendire has been identified by Mr. Gerrit S. Miller, Jr. as a dark form of *V. yumanensis*.

SMALL BROWN BAT. *Vespertilio lucifugus longicrus*, True.

On the evening of August 25 Mr. Bailey shot one of these bats at Upper Sink Creek, near the east base of the range.

Several small bats were seen at the rim of Crater Lake, but unfortunately we were not able to secure a specimen.

SILVER-HAIRED BAT. *Lasionycteris noctivagans*, (Le Conte).

When camped on Upper Sink Creek, the night of August 25, I shot a silver-haired bat as it was flying overhead in the short twilight. It is odd that the three bats killed at this place the same evening belong to three different genera (*Lasionycteris noctivagans*, *Vespertilio lucifugus longicrus*, and *Eptesicus fuscus*.)

LARGE BROWN BAT. *Eptesicus fuscus*, (Palisot de Beauvois).

Common about the base of the mountain and ranging up the canyon of Anna Creek nearly as far as Pole Creek, where several were shot by Mr. Preble. The species is common at Fort Klamath and one was killed on Upper Sink Creek.

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LARGE PALE BAT. *Antrozous pallidus*, (Le Conte).

Three specimens of this large, handsome long-eared bat were sent me from Fort Klamath some years ago by Major Charles E. Bendire, who collected them there in 1883. They belong to the large California form which ranges northward on the east side of the Cascades to the Dalles.

Department of Agriculture, Washington, D. C.

U. S. Fish Commission Investigations at Crater Lake.

BARTON WARREN EVERMANN, PH. D.
Ichthyologist of the United States Fish Commission.

In the spring of 1896 the U. S. Commissioner of Fish and Fisheries received a request from the Mazamas and also from public spirited citizens of south-western Oregon that a plant of fish be made in Crater Lake.

No one seemed to know whether the physical and biologic conditions existing at Crater Lake were such as would permit fish to thrive in it. Before acting upon the request it was, therefore, thought advisable to learn something of the character of the Lake. I was therefore directed by the Commissioner to make such an examination of the Lake as would determine its fitness for fish life.

The investigation was conducted chiefly along four lines, viz: the character of the water as to purity, temperature, etc., the nature and amount of fish-food found in the Lake, the presence of other animal and vegetable life in and about the Lake, and the existence of bottom suitable for spawning beds.

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THE "CLEETWOOD" ON CRATER LAKE.

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It is only through œcological investigations that one may know the fitness of any body of water for any animal or plant; only through a study of the phenomena of the life-history of organisms in their individual and reciprocal relations, the consideration of the laws of animal and vegetable activities as manifested in their modes of life, can we judge the probable fate of any species it is proposed to introduce.

The study of the fauna and flora of isolated bodies of water is always full of interest to the biologist and student of geographic distribution. The more complete the isolation and the more unusual the physical conditions obtaining, the more interesting the problems presented. Crater Lake possesses such features in an unusual degree. Its location in a great pit in the top of a great mountain, the entire absence of inlets and outlets (unless subterranean), the immense height and verticality of its surrounding wall, its profound depth, and the wonderful blue of its waters,—these give it a unique place among the lakes of the world. The remarkable clearness and the marvelous blue of the water of Crater Lake are well known to all who have ever visited it and need not be dwelt upon here.

So far as I know no analysis has ever been made of the water. It is evident that it contains some minerals in solution, though in small quantities. To the taste it is sweet but somewhat flat, and there is no reason to believe that it would not prove wholesome and suitable in every way for fish-life. Considerable time was devoted to taking temperatures in different parts of the Lake and at different depths. The following table gives the surface temperatures obtained in different places and at different hours:

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SURFACE TEMPERATURES AT CRATER LAKE.

DATE	HOUR	STATION	Temperature in Fahr. Degrees
Aug. 19, 1896	4.00 P. M.	From shore in Eagle Cove.....	59°
" 20, "	9.40 A. M.	One-fourth mile from shore in Eagle Cove.....	57°
" 20, "	9.55 "	One mile from shore in Eagle Cove..	56.5°
" 20, "	10.10 "	One-fourth mile from Wizard Island.	58°
" 20, "	1.40 P. M.	One-fourth mile off Phantom Ship...	60°
" 21, "	8.45 A. M.	From shore in Eagle Cove.....	55.6°
" 22, "	9.11 "	From shore in Eagle Cove.....	56°
" 22, "	1.00 P. M.	Near center of Lake.....	62°
" 22, "	3.00 "	About 2¼ miles east of Wizard Island	61°
" 22, "	4.00 "	About 2¼ miles east of Wizard Island	61°

As many intermediate and bottom temperatures were taken as time and opportunity permitted. These temperatures were taken with a Negretti-Zambra deep-sea thermometer, tripped by means of a propeller.

The vertical series taken during the afternoon of August 22 at a station about 2¼ miles east from the southeast corner of Wizard Island, proved of very great interest. The surface temperature was 61°*; at a depth of 555 feet, 39°; at 1,040 feet 41°; and at 1,623 feet, which was at the bottom, 46°. In all other American lakes, so far as known, the coldest water in summer is always at the bottom. The effect of the sun in heating up the surface of a lake does not ordinarly reach to any great depth. Observations recently made upon Lake Chaplain by Prof. George C. Whipple, and by myself for the U. S. Fish Commission in Idaho, showed that the sun's heat did not much affect the temperature of the water beyond a depth of 100 feet.

The temperatures were taken by Prof. Whipple by means of a thermophone, and two series of observations were made where the depths were 333 and 396 feet respectively. The accompanying diagram shows the results of these observations:

*All the temperatures are recorded in Fahrenheit degrees.

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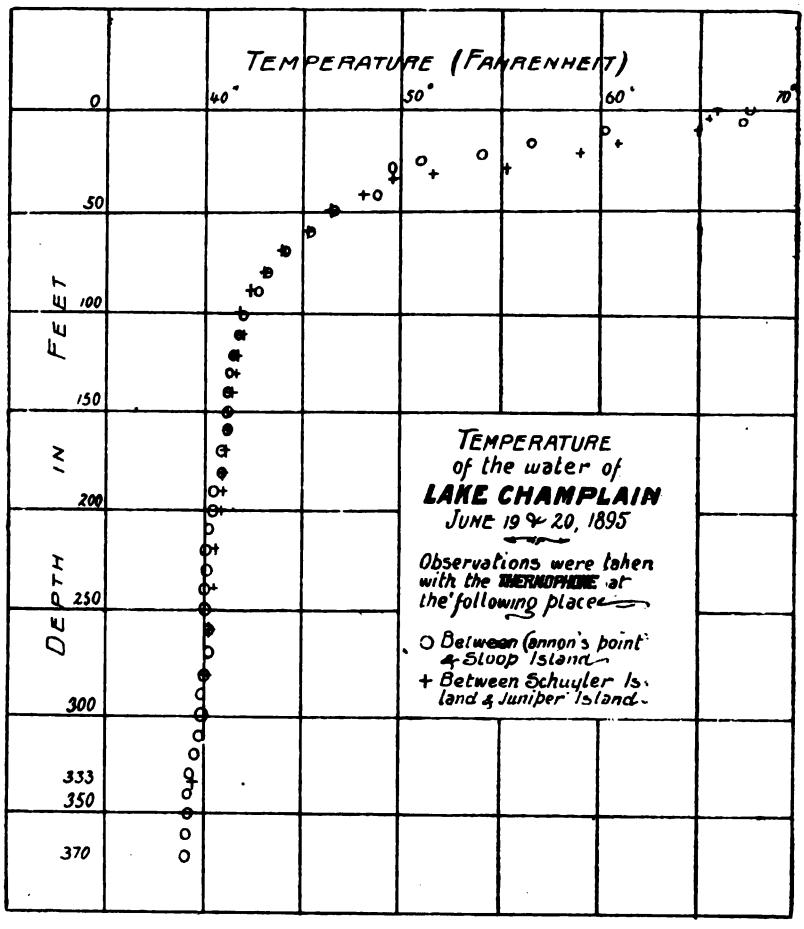

Quoting Prof. Whipple: "It will be noticed that below a depth of 50 feet the readings at the two places agreed almost exactly; above that point they differed somewhat, but each curve preserved its regularity. It is interesting to observe how great a change of temperature there was in the first 50 feet below the surface, and how slight a change there was below that depth. At a depth of 100 feet the water was but 3° warmer than at the bottom. At the deepest place in the lake, which was found opposite Essex, N. Y., the temperature at 370 feet was 39.35°, a point only slightly above the temperature at which water is densest. * * * * * The fact

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that this temperature so near the point of maximum density was found during the summer season indicates that the water near the bottom is in a continual state of stagnation. It is probable that there is little circulation below a depth of 200 feet."

BOTTOM AND INTERMEDIATE TEMPERATURES OF CRATER LAKE.

DATE	HOUR	STATION	DEPTH FT.	TEMPERATURE
Aug. 20, 1896	11.00 A.M.	At bottom ½ mile S. of Wizard Island.	93	43.5
" 20, "	1.40 "	At bottom ¼ mile off Phantom Ship ..	866	44
" 22, "	3.00 P.M.	About 2¼ miles east of Wizard Island.	555	39
" 22, "	4.00 "	" " " " "	1040	41
" 22, "	5.00 "	At bottom east of Wizard Island	1623	46

If there be no error in our observations, it seems certain that the waters of Crater Lake are still receiving heat from the rock upon which they rest. The heat of the old volcano has not entirely disappeared. The coldest water is neither at the bottom nor at the surface, but at some intermediate depth. The results of these observations are so unexpected, and the indicated conditions are so unusual, that the matter should receive further attention. The only possible source of error which has yet suggested itself is that the propeller may not always have worked properly. It is possible that, in some cases, when we began hauling up the thermometer, the propeller failed to reverse until some moments later, in which case the reading would be that for some depth other than the one desired. This is a possibility, though it seems to me improbable. The observations should be carefully repeated before the conclusions suggested by the results should be accepted.

PLANTS AND ANIMALS OF CRATER LAKE.

For collecting the life forms living in the waters of the Lake, fine-meshed towing nets were used. Owing to the difficulty of securing the use of a boat as often as was desirable, our plankton investigations were not as complete as we should otherwise have made them. The majority of our collections were obtained between the boat-landing at the foot of the trail and Wizard Island. Though the amount of surface towings obtained seemed to be small, it is

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gratifying to know that not fewer than 4 species of plants and 8 species of animals were collected in that manner, and at least 7 more species of animals were found on or among the rocks along the shore of Wizard Island and Eagle Cove.

Mammals and birds excepted, only 3 species of vertebrates were found within the rim of Crater Lake, viz.: a snake, a frog, and a salamander. The snake is the small-headed striped snake, *Thamnophis leptocephalus*, (Baird & Girard). Two specimens were obtained on Wizard Island. It was not seen elsewhere.

One specimen of a frog, *Rana aurora*, Baird & Girard, was also obtained on Wizard Island. Other examples were seen about the spring below the camp. The species of salamander is *Amblystoma macrodactylum*, Baird. It is by far the most abundant and interesting vertebrate occurring at Crater Lake. Our first specimens were found on the shore under Red Cloud Cliff, where we found it to be exceedingly abundant. It was afterwards found in considerable numbers along the shore in Eagle Cove, and a few were obtained about Wizard Island. More than a hundred specimens were collected, and many more could have been obtained. The majority of the individuals seen were adults; only 4 or 5 still retaining the external gills were seen. These salamanders were found under the rocks, just above the edge of the water of the Lake. Sometimes as many as a dozen or fifteen were found under a single flat stone. These three species are not uncommon throughout Western Oregon and Washington.

Invertebrate life was found to be fairly abundant, and a few plants were found. By using fine-meshed surface towing nets considerable collections were made. The following is a list of the species obtained:

PLANTS, ALGAE:

1. *Nostoc* sp.? Colonies common.
2. *Melosira granulata*, L. W. Bail. Not common.
3. *Pleurosigma* sp.? Several specimens.
4. *Surirella* sp.? Not common.

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ANIMALS, CRUSTACEA:

5. *Cyclops albidus*, Jurine. Not common.
6. *Cyclops serrulatus*, Fischer. Not common.
7. *Daphnia pulex pulicaria*, Forbes. Very abundant.
8. *Allorchestes dentata*, Smith. Not common.

INSECTA:

9. *Chironomus* sp.? larvæ. Very common.
10. *Ephemerid* larvæ. Common.
11. *Limnophilus* or Caddis-fly. Very abundant.
12. *Laccophilus* larvæ. Not common.
13. *Deronectes striatellus*, Lec. Not common.
14. *Dytiscus* sp.? Not rare.

VERMES:

15. *Gordius* sp.? One specimen obtained.
16. A species of leech. Not uncommon.

MOLLUSCA:

17. *Physa* sp.? Not uncommon.

BATRACHIA:

18. *Amblystoma macrodactylum*, Baird.
19. *Rana aurora*, Baird & Girard.

REPTILIA:

20. *Thamnophis leptocephalum*, Baird & Girard.

Crater Lake contains no fishes—lakes without inlets or outlets seldom or never do, for fishes naturally get into one body of water only by swimming to it from some other body of water with which it is connected. Fishes never appear *de novo* in any lake or stream; if they appear there at all, it is because they can get there from some other lake or stream. Breaks in water continuity, or even considerable falls, are absolute barriers beyond which fishes cannot go. So it is with Crater Lake. It has never had an inlet or outlet connecting it with any other body of water in which fishes are found, and through which fishes might reach it.

Plant life is very scarce indeed. The 4 species of algæ are all inconspicuous; only the *Nostoc* being at all noticeable to the naked eye. It was quite common on the rocks about Wizard Island. The

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little shell (*Physa*) was rather common about the Island, but was not seen elsewhere. Of the 4 species of crustaceans (*Daphnia pulex pulicaria*, was by far the most abundant, though the 2 species of *Cyclops* were not rare. Insect larvæ were very common; some species, such as the *Ephemerid*, even abundant. Caddis-fly cases were very abundant on the under sides of the rocks lying in the edge of the water. A small black leech was quite common; a species of water beetle (*Dytiscus*) was pretty common; and Dr. W. B. Knapp found a single specimen of an interesting species of *Gordius*, or Hair Snake, on the shore of Wizard Island. These crustaceans and insect larvæ are all excellent food for trout, and were found in considerable abundance, particularly in Eagle Cove and about Wizard Island.

Summing up the matter, it may be said that while the conditions obtaining at Crater Lake are not the most favorable to fish-life, there seems to be no reason why trout in limited numbers might not thrive in it. The water is all that could be desired as to purity and temperature, but the depth is so uniformly great that only small areas of bottom suitable for spawning beds are found. The entire absence of all other fish-life, and the very limited vegetation supported by the Lake, reduce the food supply almost wholly to small free-swimming crustaceans and insect larvæ. Both of these are present in considerable abundance, but probably not in sufficient quantities to support a large number of fishes. On the other hand, any fishes which may be planted in this Lake will have no rapacious fishes with which to contend; the struggle will, therefore, be wholly with the physical environment and the food supply. It has, therefore, been recommended that a plant of trout be made in Crater Lake; and it is hoped that the Mazamas who visit the Lake hereafter may make observations to determine the result of the experiment.

During the trip of the Mazama party from Ashland to Crater Lake and return, a good many temperature observations were made. All of these possess a certain value, and it has been thought proper to record them in this connection. The air temperatures were all in the shade unless otherwise stated. The instrument used was a Wilder protected thermometer.

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MISCELLANEOUS TEMPERATURES RECORDED ON THE CRATER LAKE TRIP, AUGUST 11 TO 26, 1896.

DATE	HOUR	STATION	AIR	WATER
Aug. 13	9.10 P. M.	Hunt's Ranch, 4,400 ft. elevation	54°	.....
" 14	5.00 A. M.	" " " "	41°	.....
" "	9.10 P. M.	Camp at Lake of the Woods	61°	.....
" 15	5.00 A. M.	" " " "	46°	.....
" "	12.18 P. M.	Creek at noon lunch on way to Mount Pitt	.....	54°
" "	2.00 "	Spring on creek on way to Mount Pitt	.....	42.75°
" 16	4.00 A. M.	Camp on side of Mount Pitt	50°	.....
" "	9.42 "	Summit of Mount Pitt, 9,760 ft	55°	.....
" "	11.30 "	" " " " in sun	83°	.....
" 17	4.40 "	Camp returning from Mount Pitt	37°	.....
" "	12.30 P. M.	Large spring at Pelican Bay	.....	43°
" "	" "	Small " " "	.....	43.5°
" "	" "	Creek 100 yds. below spring at Pelican Bay	.....	44.75°
" "	" "	" 400 " " " "	.....	45.5°
" "	" "	" at entrance of Pelican Bay	.....	47°
" "	" "	Air in shade at Pelican Bay	77°	.....
" "	2.14 "	" " " "	80°	.....
" "	8.00 "	Crane Creek Camp, 3,900 ft	52°	.....
" "	10.20 "	" " " "	44°	.....
" "	10.20 "	Creek at Crane Creek Camp	.....	41.5°
" 18	5.00 A. M.	" " " "	.....	41°
" "	5.00 "	Air at Crane Creek Camp	36°	.....
" "	8.30 "	Wood river at Bridge	.....	45°
" "	6.30 P. M.	Camp 2⅛ miles from Crater Lake, 6,100 ft	.....	43°
" 19	5.25 A. M.	" " " " " "	49°	39°
" "	1.20 P. M.	Camp Mazama, Crater Lake, 7,185 ft	66°	.....
" "	3.00 "	Small stream on trail down to Lake	.....	45°
" "	11.00 "	Camp Mazama	56°	.....
" 20	6.00 A. M.	" "	54°	.....
" "	12 00 M.	" "	67.5°	.....
" "	10.00 P. M.	" "	52°	.....
" 21	6.00 A. M.	" "	51°	.....
" "	8.45 "	" "	58°	.....
" "	2.30 P. M.	" "	61°	.....
" "	8 00 "	" "	58.5°	.....
" "	10.20 "	" "	55°	.....
" 22	6.00 A. M.	" "	52°	.....
" "	9.00 "	" "	66°	.....
" "	4.00 P. M.	" "	59°	.....
" 23	7.35 A. M.	" "	65°	.....
" "	9.00 "	" " Cathedral Spring	66°	35.5°
" "	12.20 P. M.	" "	69.5°	.....
" "	3.00 "	" "	70.5°	.....
" "	9.00 "	" "	59°	.....
" 24	5.00 A. M.	" "	62°	.....
" "	9.00 P. M.	Rogue river Camp, 2,300 ft. elevation	61°	.....
" 25	5.50 A. M.	" " " " "	46°	.....
" "	9.00 P. M.	Jackson's Ranch Camp, 1,300 ft. elevation	65°	.....
" 26	6.00 A. M.	" " " " "	57°	.....

United States Fish Commission, Washington, D. C.

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MOUNT PITT, FROM NORTH.

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The Mazamas' Outing of 1896.

C. H. SHOLES.

The really valuable history of our Crater Lake outing cannot be written, it having no existence outside the individual influence realized by those who took part in it. It were easy to describe the scenes, incidents and experiences of the trip; but of the vital life of the occasion, of those observations and impressions which, often unconsciously, pollinate the receptive mind, such an account would contain little more than would be found of the fragrance and beauty of a flower in a botanical description. It is in the abundance of this evanescent quality, this indescribable aroma—surest prophecy of of fruit, yet fleeting as a dream—that we shall find the permanent value, if value they have, of our annual outings.

The need of association with nature is seldom seriously questioned, nowadays, outside persons of the narrowest commercial spirit (and one of the brightest signs of our improving civilization is the growth of this nature-love among business men), but the method often is both disputed and ridiculed. It is true the educated eye and susceptible heart can enjoy nature always, although in the narrow confines of city life the picture lacks attraction and verve; but in the annual outings of the Mazamas they voluntarily put themselves, as Emerson happily says, "in parallelism with nature's streaming forces," and the receptivity of the mind is greatly increased. Amid such favorable seasons and surroundings a blossom-time, as it were, is awakened in the mind, and in the intimate companionship with nature which the rude necessities of these outings continually enforce, every contact with her laws,

> "Every press of my foot to the earth springs a hundred affections;
> They scorn the best I can do to relate them."

Asked to name the most significant features of the whole trip—the experiences which appealed most deeply to the heroic in humanity, and those which dwell with fondest longing in the

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memory—I should answer, the ascent of Mount Pitt, and the camp-fire symposiums at the Lake.

The ascent of a mountain elevated to the hight of perpetual snow in a climate so temperate as this is a symbol of human life and its struggle, and is therefore always interesting and attractive to aspiring men and women. To accomplish such a feat implies physical hardships and endurance, and almost always intellectual vigor, imagination, and a high appreciation of nature in her wildest and most exalted moods. To the thirty-two men and women, who on the morning of August 15, set forth to traverse eighteen miles of, to them, trackless forest, in order to climb to the summit of a peak remote from the haunts of men, however charming the prospect at the outset, while enthusiasm buoyed the mental and physical being to the hight of exaltation, the happy start soon grew into stern reality as hour after hour sped while the long cavalcade pursued its devious way, now and then a glimpse of the objective peak gleaming through an opening glade, reviving hope and cheering the weary. Luncheon was seasoned with jollity and good nature, thirst quenched from the pure cold water of a mountain brook that noisily gurgled its gratitude for the happy company that with unaffected and delightful informality honored its mossy fern-covered banks. Canteens were filled, the remains of lunches repacked, and (fortunately not knowing that this was the last water we should have for thirty hours) we were once more threading the forest, climbing long ridges, descending gentle slopes, crossing huckleberry glades with too brief pause for toll, winding tortuously through dense groves of chapparal, often halting while experienced mountaineers reconnoitered, until the reverberating whistle or halloo challenged another advance. Thus the long afternoon, too short for our aim, wore away; the sun sank behind Mount Pitt, while the peak in the grayish tint of departing day seemed farther off than in the rosy morning. Footsore and weary, needing food and drink, the desired camp far up in the indefinite distance; even then scarcely a voice lost its exultant tone. As difficulties increased and obstacles multiplied unexpectedly, the unconquerable spirit of the mountaineer rejoiced while it vanquished them. Not until dusk, succeeded by the fast-following night on the shaded side of a great mountain, was a forced

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camping place reached — forced because of the impossibility of getting the pack-animals over the giant boulders and masses of jagged flinty rock that from this point to the summit impeded our progress. Ere the party could adjust itself to the situation and decide what to do, darkness shut down; packs were thrown off helter-skelter and devoted to their proper uses by the sense of touch; fires were lighted, and scouts wandered over the vast dust-dry moraines in a vain search for water, finally after long weary jaunts returning with huge pieces of snow as a substitute. Soon a much relished meal, consisting of hot coffee, bacon and cold biscuit, was served. Couches of rock made tolerable by a few hastily gathered fir boughs were quickly sought, and after a night of such refreshing slumber as is known only to the tired mountaineer, we arose before dawn and

> "Ascended a hill, and looked at the crowded heaven,
> And we said to our spirits, when we become the enfolders of those orbs, and the pleasure and knowledge of everything in them, shall we be filled and satisfied then?
> And our spirits said, *No; we but level that lift to pass and continue beyond.*"

And at eleven o'clock all except two, who felt unable to continue the ascent beyond the camp, stood on the sharp apex of Mount Pitt, where Old Glory, on an alpenstock, floated above them in the gentle breeze.

As the ascent of Mount Pitt was the chief physical feature, so the informal lectures and talks on scientific subjects, and the exercises on Mazama Day at Crater Lake, made up the distinctive literary treat of the outing. Zoology, Ichthyology, Botany and Geology were the scientific subjects under special investigation, though incidentally numerous other themes of peculiar interest to mountaineers were entertainingly discussed.

Dr. C. Hart Merriam, Chief of the Biological Survey, exhibited a diversity of small animal life which had been captured by himself and his assistant, Mr. Bailey, explained how its distribution had been modified by latitude and altitude, and the effect thereon of the glacial period when the physical marvels of this region were being fashioned. He also gave an interesting account of the work of the Survey, one important result of which was the division of the earth's surface into well-marked life-zones,

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In the realm of botany a wonderfully rich field lay about us, with all the variety which a range of altitude from 3,000 to 8,000 feet would exhibit, including besides plants and flowers, many species of conifers. These Prof. F. V. Coville, Chief of the Botanical Division of the Department of Agriculture, laid under contribution, illustrating his remarks with specimens, many of which were gathered from the floor of the lecture-room, as it were, in which he entertained his delighted audience.

In Ichthyology the investigations of Prof. B. W. Evermann and his assistant, Prof. Cox, gave mainly negative results, though not less valuable for that, as they determined to a certainty the absence of fish in the Lake, notwithstanding the natural requirements for their life and growth were abundantly present. Within the short time, and with the inadequate means for exploration at their command, they visited considerable portions of the Lake, gathered a great variety of insect and infusorial life, and made a number of temperature soundings, one of which disclosed the remarkable fact that the water was two or three degrees warmer at a depth of 1,000 than of 500 feet.

Prof. J. S. Diller, of the Geological Survey, briefly described the geological development of the mountain ranges of Southern Oregon which converge at and around Crater Lake, following with an extremely interesting account of the peculiar physical features of the Lake and mountain, and how the latter, at that time presumably one of the highest peaks of the Cascade Range, was sacrificed in the creation of one of the most beautiful and interesting objects to be found in any mountain range in the world.

It is not possible, nor does it come within the scope of this article, to give even a resumé of the various camp-fire lectures. No account, however accurate or eloquent, can make good the loss to those who did not hear them; while to those who did, the mere recollection of them will remain one of the pleasantest and longest-to-be-remembered experiences of this altogether delightful outing.

Portland, Oregon.

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The Measurement of Altitudes.

HENRY GANNETT.

There are in use numerous methods of measuring altitudes, differing widely in the principles employed, the instruments used and the accuracy of their results. Of these various methods I propose here to describe *in extenso*, only those two which are most applicable to the conditions and resources of the members of alpine clubs.

All hight measurements are relative, i. e., the difference in the hight of two places is measured, not the absolute hight of one place above the sea, unless the lower of the two stations happens to be at sea level.

MEASUREMENT OF HIGHTS BY BAROMETER.

The first of these methods to be described is the barometric method, and what is here said applies especially to the cistern barometer, the use of the aneroid being described later.

The barometric method of hight measurement depends upon the relative pressure of the air at two stations of observation. At sea level the air presses down with a force sufficient to raise mercury in a closed glass tube to an average hight of about 30 inches. At an elevation of 10,000 feet the atmospheric pressure remaining is sufficient to raise the mercury only 21 inches. In other words, nearly one-third of the atmosphere is beneath 10,000 feet. At 14,000 feet the column of mercury stands at about 18 inches. Two-fifths of the atmosphere are below this altitude and only three-fifths above it. Now, by turning this process about and measuring the hight of the column of mercury, we can, by computation, learn the difference in hight between the two stations at which such observations are made.

The instruments required for this work are portable cistern bar-

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ometers, the best of which are made by H. J. Green, of Brooklyn, N. Y. Attached to these barometers are thermometers, for indicating the temperature of the mercury in the barometers. The only other instruments necessary are thermometers for ascertaining the temperature of the air.

The mountain barometer, as the portable form is called, consists of a cistern into which dips the open lower end of a glass tube 31 or 32 inches long, the whole being inclosed in a brass case. The tube has an interior diameter of about a quarter of an inch, which toward the lower end is drawn out to a less diameter, where it dips into the cistern. The cistern consists of a number of parts. It includes a short glass cyclinder, below which is fitted the inverted frustum of a hollow cone of boxwood. This is succeeded below by a second frustum placed upright, from the lower end of which depends a buck-skin bag. The latter is raised or lowered by means of a screw at the bottom of the brass case of the cistern. The cistern is closed at the top by a boxwood ring, which is fitted to the top of the glass cylinder. The cistern and the tube are connected by means of an annular piece of kid, which is securely lashed to the boxwood ring and to the barometer tube. From the under surface of the boxwood ring depends an ivory point about a quarter of an inch in length. Upon the brass casing of the tube is a graduation into inches and twentieths, by which, with the aid of verniers, the scale may be read to two thousandths of an inch. To this brass case is attached a thermometer for indicating the temperature of the instrument. For carriage the thermometer is placed in a wooden case, fitted to its shape, and this in turn in a case of heavy leather, fitted with a shoulder strap. To fit it for carriage the mercury should be raised until it fills the cistern and tube very nearly full by turning the screw at the bottom of the case. It should always be carried in an inverted position, with the top of the tube downward.

To read the instrument it should be hung where it can swing freely. Then, by lowering the screw at the bottom, drop the mercury in the cistern until its top just touches the ivory point above mentioned. This can be best effected by making the ivory point and its reflection from the surface of the mercury barely touch one

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another. Then move the vernier until its bottom is just tangent to the convex top of the mercury in the tube.

The vernier is read like other verniers and requires no special explanation. Besides reading the hight of the column of mercury in the barometer, it is necessary to read its temperature by means of the attached thermometer, and also the temperature of the air by means of a thermometer hung in the shade.

The barometer is used differentially—that is, the difference in hight between two points is determined by the difference in the indications of the two barometers, one at each point. In order to obtain the hight above sea level of one of these points, that of the other must be known. The latter is called the base station, and its altitude should be determined either by leveling or by a long series of barometric observations referred to some other point whose altitude has been established. The proper selection of a base station or a system of base stations for reference of work to be done in a certain locality is a matter involving considerable judgment and a knowledge of the peculiar errors to which the barometer is liable, as well as a knowledge of the topography of the country and its probable influence upon the fluctuations of barometric pressure. The base station should be near the middle of the area. If but one base station is employed, it should, if possible, be near the middle altitude of the region. If two be used, one should be at the altitude of the low or valley country, and the other should in altitude be near the high summits.

Comparisons should be made at the outset between the readings of the base barometers and the readings of those to be used in the field. These comparisons should be made with the barometers hung side by side and should be made in full—i. e., by lowering the mercury in the tube and cistern until its surface just touches the ivory point, and resetting the verniers at each reading. The attached thermometers should also be read. Both barometers should be read by the same observer. A half-dozen observations made at intervals of half an hour will answer as well as a greater number. Such comparisons should, if practicable, be made at the beginning and the end of the season, and whenever a new tube is put into either barometer, or after any repairs to either instrument.

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The discrepancies between the readings of two barometers are due to several causes, among which are differences in setting of the scale of inches, differences in the caliber of the tubes, causing different amounts of capillarity, and differences in the perfection of the vacuums of the tubes. Differences due to the first two are generally trifling, amounting to but a few thousandths of an inch. If large discrepancies exist, they are usually due to the last cause, and this should be corrected.

The cistern barometer is a very frail instrument, and although in the mountain form it is protected from accident as thoroughly as possible, still tubes are not infrequently broken while in the field. It is necessary, therefore, to provide the requisite means for making repairs, such as sealed tubes, distilled mercury, etc. When a tube is broken the barometer should be opened at once and the mercury poured out, in order to prevent it from dissolving the screws and other brass work of the instrument.

The work of filling and replacing a tube is a delicate operation. After taking the barometer to pieces, the new tube should be opened by breaking off the small end, the break being made at a distance from the stricture equal to that upon the old tube. It should be effected by cutting it around with a sharp file, when a little pressure will cause it to break; then the edge of the break should be smoothed with the file. The collar which forms the top of the cistern should then be lashed on to the tube at the stricture. The mercury to be used should be very pure, and to clear it from mechanical impurities, it should be strained through chamois skin immediately before use. It should then be poured into the tube through a paper funnel, and the tube filled to within an inch of the top. Then, covering the open end of the tube with the finger, protected by a piece of kid, invert the tube, letting the bubble of air slowly traverse the tube up and down for the purpose of collecting the minute air bubbles which may have remained in the tube. Do this repeatedly, if necessary, until the mercury appears perfectly clear of bubbles. Then fill up the tube with mercury, drawing out with a straw any bubbles that there may be near the top. Slip the tube into the case, put on the glass ring and the upper cone of the cistern, and screw them togeth-

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er. Then fill the cistern with mercury, put on the lower cone, with the bag and the brass cover, and the work is complete. The test of a satisfactory result is the sound made by the column of mercury as it strikes the top of the tube when the top of the tube is reversed. If there is a sharp metallic click, the vacuum is good, but if the sound is muffled the vacuum is not perfect and must be improved. It is well to warm the mercury before pouring it into the barometer, in order to drive out any moisture in it. This is especially advisable if the atmosphere is damp at the time.

It is, by some, thought to be advisable to boil the mercury in the tube during the operation of filling. This is usually done over an alcohol lamp, two or three inches of mercury being poured into the tube at a time and brought to a boil until the tube is filled. The mercury which is to be poured into the cistern is then also boiled. This is a very delicate and tedious operation, and is attended with much risk to the tubes. Its utility is questionable, inasmuch as the mercury in the barometer is exposed to the atmosphere and soon contains as much moisture as before.

It often becomes necessary to clean the surface of the mercury in the cistern. To do this, take off the lower cone of the cistern; then, placing the finger, protected by a piece of kid, over the open end of the tube, invert the barometer slowly and pour out the mercury from the cistern. Strain it through chamois skin, replace it in the cistern, and put the latter together again.

Observations at the base stations, should, if practicable, be made hourly from 7 A. M. to 9 P. M., in order to insure having base observations coincident with those taken in the field. When not practicable to do this, they should be made at 7 A. M., 2, 6 and 9 P. M. Each observation should include the reading of the attached and detached thermometers. Whenever the observations at a station of the United States Weather Bureau are available, they should be used as base observations.

In field work, barometers should be read at each camp hourly during the day time, if practicable; if not, at such hours as to correspond with the readings at the base station and with readings made upon mountains, as prearranged, having in view the use of the camp as a secondary base station.

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Measurements of hight with cistern barometers are subject to periodic and accidental errors. The periodic errors are probably due to imperfections in the formulas and constants used in the reduction. Many attempts, both from theoretical and practical points of view, have been made to remedy these defects, but thus far without success. The accidental errors are due to errors of observation and to local differences in the pressure of the air at the points at which observations are made. Where the horizontal distance between the two stations compared is great, such differences may be correspondingly great, and the same is true where there is a considerable difference of elevation between the two stations.

In arranging plans, therefore, for measuring the hights of mountains, the base stations should be placed as near the mountains as practicable, and, whenever possible, at a considerable elevation.

REDUCTION OF BAROMETRIC OBSERVATIONS.

The atmospheric pressure at sea level is approximately equivalent to that of a column of mercury 30 inches in hight, or about 15 pounds per square inch of surface. As we rise above the earth's surface the pressure diminishes, but not in a simple ratio to the altitude, as would occur if the air had everywhere the same density. The density is proportional to the pressure, and as the pressure upon each layer is produced by the body of air above it, each successive layer of air is necessarily less dense than that which underlies it. The relation between altitude and atmospheric pressure has been stated as follows: "The difference in hight of any two localities is equal to a certain constant distance, multiplied by the difference between the logarithms of the air pressure at the two localities."

This relation gives the first principal term in the various tables for the reduction of barometric work. Different determinations of the constant distance, which is known as the pressure constant, have been made and are used in different barometric tables. Of these tables that which is most convenient, and is employed most frequently, is Guyot's (*Table I.*), to which reference was made above. The formula from which these tables were derived, which is that of La Place, is as follows, when reduced to English measures:

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$$Z = \log.\frac{h}{H} \times 60158.6 \text{ English feet} \left\{ \begin{array}{l} \left(1+\frac{t+t'-64}{900}\right) \\ (1+0.0026\cos 2L) \\ \left(1+\frac{Z+52252}{20886860}+\frac{h}{10443430}\right) \end{array} \right.$$

h = the observed hight of the barometer
τ = the temperature of the barometer
t = the temperature of the air
} at the lower station;

h' = the observed hight of the barometer
τ' = the temperature of the barometer
t' = the temperature of the air
} at the upper station.

Z = the difference of level between the two barometers;

L = the mean latitude between the two stations;

H = the hight of the barometer at the upper station reduced to the temperature of the barometer at the lower station; or,

$$H = h' \{1+0.00008967 (\tau-\tau')\}.$$

Table I. gives, in English feet, the value of log. H or $h \times 60158.6$ for every hundredth of an inch, from 17.5 to 31 inches in the barometer, together with the value of the additional thousandths, in a separate column. These values have been diminished by a constant, which does not alter the difference required.

Table II. gives the correction 2.343 feet $\times (\tau-\tau')$ for the difference of the temperature of the barometers at the two stations, or $\tau-\tau'$. As the temperature of the upper station is generally lower, $\tau-\tau'$ is usually positive and the correction negative. It becomes positive when the temperature of the upper barometer is higher and $\tau-\tau'$ negative. When the hights of the barometers have been reduced to the same temperatures, or to the freezing point, this table will not be used.

Table III. gives a small correction for the difference of the force of gravity in different latitudes.

Table IV. shows the correction $D' \frac{z+52252}{20886860}$ to be applied to

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the approximate altitude for the decrease of gravity on a vertical acting on the density of the mercurial column. It is always additive.

Table V. furnishes the small correction $\frac{h}{10443430}$ for the decrease of gravity on a vertical acting on the density of the air; the hight of the barometer h at the lower station representing its approximate altitude. Like the preceding correction it is always additive.

Use of the Tables.

In Table I. find first the numbers corresponding to the observed hights of the barometer h and h'. Suppose, for instance, h=29.345 in.; find in the first column on the left the number 29 3; on the same horizontal line, in the column headed .04, is given the number corresponding to 29.34=28121.7; in the last column but one on the right, we find for .005=4.5, or for 29.345=28126.2. Take likewise the value of h', and find the difference.

If the barometrical hights have not been previously reduced to the same temperature, or to the freezing point, apply to the difference the correction found in Table II. opposite the number representing $\tau-\tau'$; we thus obtain the approximate difference of level, D.

For computing the correction due to the expansion of the air according to its temperature, or $D \times \left\{ \frac{t+t'-64}{900} \right\}$, make the sum of the temperatures, subtract from that sum 64; multiply the rest into the approximate difference D, and divide the product by 900. This correction is the same sign as $(t+t'-64)$. By applying it, we obtain a second approximate difference of level, D'.

In Table III., with D' and the mean latitude of the stations, find the correction for variation of gravity in latitude, and add to D', paying due attention to the sign.

In Table IV., with D', and in Table V. with D' and the hight of the barometer at the lower station, take the corrections for the decrease of gravity on a vertical, and add them to the approximate difference of level.

The sum thus found is the true difference of level between the two stations, or Z; by adding the elevation of the lower station above the level of the sea, when known, we obtain the altitude of the upper station.

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TABLE I.—ARGUMENT, OBSERVED HIGHT OF BAROMETER AT EACH STATION.

Barometer in Eng. Inch.	Hundredths of an Inch.										Thousandths of an Inch.		Barometer in Eng. Inch.
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09			
	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.		Feet.	
17.5	14620.9	14635.8	14650.7	14665.6	14680.5	14695.4	14710.3	14725.2	14740.1	14754.9	2	2.9	17.5
17.6	14769.8	14784.6	14799.4	14814.3	14829.1	14843.9	14858.7	14873.5	14888.2	14903.0	3	4.4	17.6
17.7	14917.8	14932.5	14947.3	14962.0	14976.8	14991.5	15006.2	15020.9	15035.6	15050.3	4	5.8	17.7
17.8	15065.0	15079.6	15094.3	15109.0	15123.6	15138.2	15152.9	15167.5	15122.1	15196.7	5	7.3	17.8
17.9	15211.3	15225.9	15240.5	15255.0	15269.6	15284.2	15298.7	15313.3	15327.8	15342.4	6	8.8	17.9
18.0	15356.8	15371.3	15385.8	15400.3	15414.8	15429.3	15443.7	15458.2	15472.7	15487.1	7	10.2	18.0
18.1	15501.5	15516.0	15530.4	15544.8	15559.2	15573.6	15588.0	15602.4	15616.8	15631.2	8	11.7	18.1
18.2	15645.5	15659.9	15674.2	15688.5	15702.9	15717.2	15731.5	15745.8	15760.1	15774.4	9	13.1	18.2
18.3	15788.6	15802.9	15817.2	15831.4	15845.7	15859.9	15874.2	15888.4	15902.6	15916.8			18.3
18.4	15931.0	15945.2	15959.4	15973.6	15987.8	16001.9	16016.1	16030.2	16044.4	16058.5			18.4
18.5	16072.6	16086.8	16100.9	16115.0	16129.1	16143.2	16157.3	16171.3	16185.4	16199.5			18.5
18.6	16213.5	16227.6	16241.6	16255.6	16269.7	16283.7	16297.7	16311.7	16325.7	16339.6			18.6
18.7	16353.5	16367.5	16381.5	16395.4	16409.4	16423.3	16437.2	16451.2	16465.1	16479.0	1	1.4	18.7
18.8	16492.9	16506.8	16520.7	16534.6	16548.5	16562.3	16576.2	16590.0	16603.9	16617.8	2	2.7	18.8
18.9	16631.5	16645.4	16659.2	16673.0	16686.8	16700.6	16714.4	16728.1	16741.9	16755.7	3	4.1	18.9
19.0	16769.4	16783.2	16796.9	16810.6	16824.3	16838.1	16851.8	16865.5	16879.2	16892.8	4	5.4	19.0
19.1	16906.5	16920.2	16933.9	16947.5	16961.2	16974.9	16988.5	17002.1	17015.8	17029.4	5	6.8	19.1
19.2	17043.0	17056.6	17070.2	17083.8	17097.4	17110.9	17124.5	17138.1	17151.6	17165.2	6	8.1	19.2
19.3	17178.7	17192.2	17205.8	17219.3	17232.8	17246.3	17259.8	17273.3	17286.8	17300.3	7	9.5	19.3
19.4	17313.7	17327.2	17340.6	17354.1	17367.5	17380.9	17394.4	17407.8	17421.2	17434.6	8	10.9	19.4
19.5	17448.0	17461.4	17474.8	17488.2	17501.6	17515.0	17528.3	17541.7	17555.0	17568.4	9	12.2	19.5
19.6	17581.7	17595.0	17608.3	17621.7	17635.0	17648.2	17661.5	17674.8	17688.1	17701.4			19.6
19.7	17714.6	17727.9	17741.1	17754.4	17767.6	17780.8	17794.1	17807.3	17820.5	17833.7			19.7
19.8	17864.9	17860.1	17873.3	17886.5	17899.6	17912.8	17926.0	17939.1	17952.2	17965.4			19.8
19.9	17978.5	17991.6	18004.8	18017.9	18031.0	18044.1	18057.2	18070.3	18083.4	18096.4	1	1.3	19.9
20.0	18109.5	18122.6	18135.6	18148.7	18161.7	18174.8	18187.8	18200.8	18213.8	18226.8	2	2.6	20.0
20.1	18239.8	18252.8	18265.8	18278.8	18291.8	18304.8	18317.7	18330.7	18343.6	18356.6	3	3.9	20.1
20.2	18369.5	18382.5	18395.4	18408.3	18421.2	18434.1	18447.0	18459.9	18472.3	18485.7	4	5.1	20.2
20.3	18498.5	18511.4	18524.3	18537.1	18550.0	18562.8	18575.7	18588.5	18601.3	18614.1	5	6.4	20.3
20.4	18626.9	18639.7	18652.5	18665.3	18678.1	18690.9	18703.6	18716.4	18729.1	18741.9	6	7.7	20.4

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Barometer in Eng. Inch.	Hundredths of an Inch.										Thousandths of an Inch.		Barometer in Eng. Inch.
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09			
	Eng. Ft.	*Eng. Ft.*	*Eng. Ft.*	*Eng. Ft.*	*Eng. Ft.*	*Eng. Ft.*	*Eng. Ft.*	*Eng. Ft.*	*Eng. Ft.*	*Eng. Ft.*		*Feet.*	
20.5	18754.6	18767.4	18780.1	18792.9	18805.6	18818.3	18831.0	18843.7	18856.4	18869.1	7	9.0	20.5
20.6	18881.8	18894.5	18907.2	18919.9	18932.5	18945.2	18957.8	18970.5	18983.1	18995.7	8	10.3	20.6
20.7	19008.3	19021.0	19033.6	19046.2	19058.8	19071.4	19083.9	19096.5	19109.1	19121.7	9	11.6	20.7
20.8	19134.2	19146.8	19159.3	19171.9	19184.4	19196.9	19209.5	19222.0	19234.5	19247.0			20.8
20.9	19259.5	19272.0	19284.5	19297.1	19309.5	19322.0	19334.4	19346.9	19359.3	19371.8			20.9
21.0	19384.3	19396.7	19409.1	19421.5	19434.0	19446.4	19458.8	19471.2	19483.6	19496.0			21.0
21.1	19508.4	19520.8	19533.1	19545.5	19557.9	19570.2	19589.6	19594.9	19607.3	19619.6	1	1.2	21.1
21.2	19632.0	19644.3	19656.6	19668.9	19681.2	19693.5	19705.8	19718.0	19730.3	19742.6	2	2.4	21.2
21.3	19754.9	19767.1	19779.4	19791.6	19803.9	19816.1	19828.4	19840.6	19852.8	19865.0	3	3.6	21.3
21.4	19877.3	19889.5	19901.7	19913.9	19926.0	19938.2	19950.4	19962.6	19974.7	19986.9	4	4.8	21.4
21.5	19999.1	20011.2	20023.3	20035.5	20047.6	20059.7	20071.8	20083.9	20096.1	20108.2	5	6.0	21.5
21.6	20120.3	20132.3	20144.4	20156.5	20168.6	20180.7	20192.7	20204.8	20216.9	20228.9	6	7.2	21.6
21.7	20241.0	20253.0	20265.0	20277.6	20289.1	20301.1	20313.1	20325.1	20337.1	20349.1	7	8.4	21.7
21.8	20361.1	20373.0	20385.0	20397.0	20409.0	20420.9	20432.9	20444.8	20456.8	20468.7	8	9.7	21.8
21.9	20480.7	20492.6	20504.5	20516.4	20528.3	20540.2	20552.1	20564.0	20575.9	20587.8	9	10.9	21.9
22.0	20599.7	20611.5	20623.4	20635.3	20647.1	20659.0	20670.8	20682.7	20694.5	20706.3			22.0
22.1	20718.2	20732.0	20741.8	20753.6	20765.4	20777.2	20789.0	20801.8	20812.6	20824.4			22.1
22.2	20836.2	20847.9	20859.7	20871.4	20883.2	20894.9	20906.7	20918.4	20930.1	20941.9			22.2
22.3	20953.6	20965.3	20977.0	20988.7	21000.4	21012.1	21023.8	21035.4	21047.1	21058.8	1	1.1	22.3
22.4	21070.5	21082.1	21093.8	21105.4	21117.1	21128.7	21140.4	21152.0	21163.6	21175.3	2	2.3	22.4
22.5	21186.9	21198.5	21210.1	21221.6	21233.2	21244.8	21256.4	21268.0	21279.5	21291.1	3	3.4	22.5
22.6	21302.6	21314.2	21325.8	21337.3	21348.9	21360.4	21371.9	21383.5	21395.0	21406.5	4	4.6	22.6
22.7	21418.1	21429.6	21441.1	21452.5	21464.0	21465.5	21487.0	21498.5	21509.9	21521.4	5	5.7	22.7
22.8	21532.9	21544.3	21555.8	21567.2	21578.7	21590.1	21601.6	21613.0	21624.4	21635.8	6	6.8	22.8
22.9	21647.3	21658.7	21670.1	21681.4	21692.8	21704.2	21715.6	21727.0	21738.3	21749.7	7	8.0	22.9
23.0	21761.0	21772.4	21783.7	21795.1	21806.4	21817.7	21829.1	21840.4	21851.7	21863.0	8	9.1	23.0
23.1	21874.3	21885.6	21897.0	21908.3	21919.6	21930.8	21942.1	21953.4	21964.7	21976.0	9	10.2	23.1
23.2	21987.2	21998.5	22009.8	22021.0	22032.3	22043.5	22054.7	22066.0	22077.2	22088.4			23.2
23.3	22099.6	22110.8	22122.1	22133.3	22144.5	22155.6	22166.8	22178.0	22189.2	22200.4			23.3
23.4	22211.5	22222.7	22233.9	22245.0	22256.2	22267.3	22278.4	22289.6	22300.7	22311.8			23.4

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Barometer in Eng. Inch.	Hundredths of an Inch.										Thousandths of an Inch.		Barometer in Eng. Inch.
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09			
	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.		Feet.	
23.5	22322.9	22334.0	22345.2	22356.3	22367.4	22378.4	22389.5	22400.6	22411.7	22422.8			23.5
23.6	22433.8	22444.9	22456.0	22467.0	22478.1	22489.1	22500.2	22511.2	22522.3	22533.3			23.6
23.7	22544.3	22555.4	22566.4	22577.4	22588.4	22599.4	22610.4	22621.4	22632.4	22643.4			23.7
23.8	22654.3	22665.3	22676.3	22687.2	22698.2	22709.1	22720.1	22731.0	22742.0	22752.9	1	1.1	23.8
23.9	22763.8	22774.8	22785.7	22796.6	22807.5	22818.4	22829.4	22840.3	22851.2	22862.0	2	2.2	23.9
24.0	22873.0	22883.9	22894.7	22905.6	22916.5	22927.4	22938.2	22949.1	22960.0	22970.8	3	3.2	24.0
24.1	22981.7	22992.5	23003.3	23014.2	23025.0	23035.8	23046.6	23057.5	23068.3	23079.1	4	4.3	24.1
24.2	23089.9	23100.7	23111.4	23122.2	23133.0	23143.8	23154.5	23165.3	23176.1	23186.8	5	5.4	24.2
24.3	23197.6	23208.3	23219.1	23229.8	23240.5	23251.3	23262.0	23272.7	23283.4	23294.2	6	6.5	24.3
24.4	23304.9	23315.6	23326.3	23337.0	23347.6	23358.3	23369.0	23379.7	23390.3	23401.0	7	7.5	24.4
24.5	23411.7	23422.3	23433.0	23443.7	23454.3	23464.9	23475.6	23486.2	23496.8	23507.4	8	8.6	24.5
24.6	23518.1	23528.7	23539.3	23549.9	23560.5	23571.1	23581.7	23592.3	23602.9	23613.5	9	9.7	24.6
24.7	23624.1	23634.6	23645.2	23655.8	23666.3	23676.9	23687.5	23698.0	23708.6	23719.1			24.7
24.8	23729.7	23740.2	23750.7	23761.2	23771.7	23782.3	23792.8	23803.3	23813.8	23824.3			24.8
24.9	23834.8	23845.3	23855.7	23866.2	23876.7	23887.2	23897.7	23908.2	23918.6	23929.1	1	1.0	24.9
25.0	23939.5	23949.9	23960.4	23970.8	23981.3	23991.7	24002.1	24012.5	24023.0	24033.4	2	2.1	25.0
25.1	24043.8	24054.2	24064.6	24075.0	24085.4	24095.7	24106.1	24116.5	24126.9	24137.2	3	3.1	25.1
25.2	24147.6	24158.0	24168.3	24178.7	24189.0	24199.4	24209.7	24220.1	24230.4	24240.8	4	4.1	25.2
25.3	24251.1	24261.4	24271.8	24282.1	24292.4	24302.7	24313.0	24323.3	24333.6	24343.9	5	5.1	25.3
25.4	24354.2	24364.5	24374.7	24385.0	24395.3	24405.5	24415.8	24426.1	24436.3	24446.6	6	6.2	25.4
25.5	24456.8	24467.0	24477.3	24487.5	24497.8	24508.0	24518.2	24528.4	24538.7	24548.9	7	7.2	25.5
25.6	24559.1	24569.3	24579.5	24589.7	24599.9	24610.0	24620.2	24630.4	24640.6	24650.7	8	8.2	25.6
25.7	24660.9	24671.1	24681.2	24691.4	24701.5	24711.7	24721.8	24732.0	24742.1	24752.3	9	9.2	25.7
25.8	24762.4	24772.5	24782.6	24792.8	24802.9	24813.0	24823.1	24833.2	24843.3	24853.4			25.8
25.9	24863.5	24873.6	24883.7	24893.7	24903.8	24913.9	24921.0	24934.0	24944.1	24954.1			25.9
26.0	24964.2	24974.2	24984.3	24994.3	25004.4	25014.4	25024.4	25034.4	25044.5	25054.5			26.0
26.1	25064.5	25074.5	25084.5	25094.5	25104.5	25114.5	25124.5	25134.5	25144.4	25154.4			26.1
26.2	25164.4	25174.4	25184.3	25194.3	25204.2	25214.2	25224.1	25234.1	25244.0	25254.0	1	1.0	26.2
26.3	25263.9	25273.8	25283.8	25293.7	25303.6	25313.5	25323.4	25333.3	25343.2	25353.1	2	2.0	26.3
26.4	25363.0	25372.9	25382.8	25392.7	25402.6	25412.4	25422.3	25432.2	25442.1	25451.9	3	2.9	26.4

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Barometer in Eng. Inch.	Hundredths of an Inch.										Thousandths of an Inch.		Barometer in Eng. Inch.
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09			
	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.		Feet.	
26.5	25461.8	25471.7	25481.5	25491.4	25501.2	25511.0	25520.9	25530.7	25540.5	25550.4	4	3.9	26.5
26.6	25560.2	25570.0	25579.8	25589.7	25599.5	25609.3	25619.1	25628.9	25638.7	25648.5	5	4.9	26.6
26.7	25658.3	25668.1	25677.8	25687.6	25697.4	25707.1	25716.9	25726.7	25736.4	25746.2	6	5.9.	26.7
26.8	25755.9	25765.6	25775.4	25785.1	25794.8	25804.6	25814.3	25824.0	25833.8	25843.5	7	6.9	26.8
26.9	25853.2	25862.9	25872.6	25882.3	25892.0	25901.7	25911.4	25921.1	25930.8	25940.5	8	7.8	26.9
27.0	25950.2	25959.9	25969.6	25979.2	25988.9	25998.6	26008.2	26017.9	26027.5	26037.2	9	8.8	27.0
27.1	26046.8	26056.5	26066.1	26075.7	26085.3	26095.0	26104.6	26114.2	26123.8	26133.4			27.1
27.2	26143.0	26152.6	26162.2	26171.8	26181.4	26191.0	26200.6	26210.2	26219.8	26229.3			27.2
27.3	26238.9	26248.5	26258.0	26267.6	26277.2	26286.7	26296.3	26305.8	26315.3	26324.9			27.3
27.4	26334.4	26344.0	26353.5	26363.0	26372.5	26382.1	26391.6	26401.1	26410.6	26420.1	1	0.9	27.4
27.5	26429.6	26439.1	26448.6	26458.1	26467.6	26477.1	26486.5	26496.0	26505.5	26514.9	2	1.9	27.5
27.6	26524.4	26533.9	26543.3	26552.8	26562.3	26571.7	26581.2	26590.6	26600.0	26609.5	3	2.8	27.6
27.7	26618.9	26628.4	26637.8	26647.2	26656.7	26666.1	26675.5	26684.9	26694.3	26703.7	4	3.7	27.7
27.8	26713.1	26722.5	26731.9	26741.3	26750.7	26760.1	26769.5	26778.8	26788.2	26797.6	5	4.7	27.8
27.9	26806.9	26816.3	26825.6	26835.0	26844.3	26853.7	26863.0	26872.3	26881.7	26891.0	6	5.6	27.9
28.0	26900.4	26909.7	26919.0	26928.4	26937.7	26947.0	26956.3	26965.6	26975.0	26984.3	7	6.5	28.0
28.1	26993.6	27002.9	27012.2	27021.5	27030.7	27040.0	27049.3	27058.6	27067.8	27077.1	8	7.5	28.1
28.2	27086.4	27095.6	27104.9	27114.2	27123.4	27132.7	27141.9	27151.2	27160.4	27169.6	9	8.4	28.2
28.3	27178.9	27188.1	27197.3	27206.5	27215.7	27225.0	27234.2	27243.4	27252.6	27261.8			28.3
28.4	27271.0	27280.2	27289.4	27298.6	27307.8	27317.0	27326.2	27335.3	27344.5	27353.7			28.4
28.5	27362.9	27372.0	27381.2	27390.4	27399.5	27408.7	27417.8	27427.0	27436.1	27445.2			28.5
28.6	27454.4	27463.5	27472.6	27481.8	27490.9	27500.0	27509.1	27518.2	27527.4	27536.5			28.6
28.7	27545.6	27554.7	27563.8	27572.9	27582.0	27591.1	27600.2	27609.3	27618.3	27627.4	1	0.9	28.7
28.8	27636.5	27645.5	27654.6	27663.7	27672.7	27681.8	27690.8	27699.9	27708.9	27717.9	2	1.8	28.8
28.9	27727.0	27736.0	27745.1	27754.1	27763.1	27772.2	27781.2	27790.2	27799.2	27808.3	3	2.7	28.9
29.0	27817.2	27826.2	27835.2	27844.2	27853.2	27862.2	27871.2	27880.2	27889.1	27898.1	4	3.6	29.0
29.1	27907.1	27916.1	27925.0	27934.0	27943.0	27951.9	27960.9	27969.8	27978.8	27987.7	5	4.5	29.1
29.2	27996.7	28005.6	28014.6	28023.5	28032.4	28041.4	28050.3	28059.2	28068.2	28077.1	6	5.4	29.2
29.3	28086.0	28094.9	28103.8	28112.8	28121.7	28130.6	28139.5	28148.4	28157.3	28166.2	7	6.3	29.3
29.4	28175.1	28184.0	28192.9	28201.7	28210.6	28219.5	28228.4	28237.2	28246.1	28254.9	8	7.2	29.4

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Barometer in Eng. Inch.	Hundredths of an Inch.										Thousandths of an Inch.		Barometer in Eng. Inch.
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09			
	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.	Eng. Ft.		Feet.	
29.5	28263.8	28272.6	28281.5	28290.3	28299.2	28308.0	28316.9	28325.7	28334.5	28343.4	9	8.1	29.5
29.6	28352.2	28361.0	28369.8	28378.7	28387.5	28396.3	28405.1	28413.9	28422.7	28431.5			29.6
29.7	28440.3	28449.1	28457.9	28466.7	28475.4	28484.2	28493.0	28501.8	28510.6	28519.3			29.7
29.8	28528.1	28536.9	28545.6	28554.4	28563.2	28571.9	28580.7	28589.4	28598.2	28606.9			29.8
29.9	28615.7	28624.4	28633.2	28641.9	28650.6	28659.3	28668.1	28676.8	28685.5	28694.2	1	8.6	29.9
30.0	28702.9	28711.6	28720.3	28729.0	28737.7	28746.4	28755.1	28763.8	28772.5	28781.1	2	1.7	30.0
30.1	28789.8	28798.5	28807.2	28815.9	28824.5	28833.2	28841.9	28850.5	28859.2	28867.9	3	2.6	30.1
30.2	28876.5	28885.2	28893.8	28902.5	28911.1	28919.8	28928.4	28937.0	28945.7	28954.3	4	3.4	30.2
30.3	28962.9	28971.5	28980.1	28988.8	28997.4	29006.0	29014.6	29023.2	29031.7	29040.3	5	4.3	30.3
30.4	29048.9	29057.5	29066.1	29074.7	29083.3	29091.8	29100.4	29109.0	29117.6	29126.2	6	5.2	30.4
30.5	29134.7	29143.3	29151.9	29160.4	29169.0	29177.6	29186.1	29194.7	29203.2	29211.8	7	6.0	30.5
30.6	29220.3	29228.9	29237.4	29245.9	29254.4	29262.9	29271.5	29280.0	29288.5	29297.0	8	6.9	30.6
30.7	29305.5	29314.0	29322.5	29331.1	29339.6	29348.1	29356.6	29365.1	29373.5	29382.0	9	7.7	30.7
30.8	29390.5	29399.0	29407.5	29416.0	29424.4	29432.9	29441.4	29449.8	29458.3	29466.8			30.8
30.9	29475.2	29483.7	29492.1	29500.6	29509.0	29517.5	29525.9	29534.3	29542.8	29551.2			30.9

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TABLE II.—Correction for $\tau - \tau'$ or Difference of the Temperature of the Barometers at the Two Stations.

This Correction is *negative* when the attached Thermometer at the Upper Station is lowest; *positive* when the attached Thermometer at the Upper Station is highest.

$\tau - \tau'$ Fahrenheit.	Correction in Eng. feet.	$\tau - \tau'$ Fahrenheit.	Correction in Eng. feet.	$\tau - \tau'$ Fahrenheit.	Correction in Eng. feet.	$\tau - \tau'$ Fahrenheit.	Correction in Eng. feet.	$\tau - \tau'$ Fahrenheit.	Correction in Eng. feet.	$\tau - \tau'$ Fahrenheit.	Correction in Eng. Feet.	$\tau - \tau'$ Fahrenheit.	Correction in Eng. feet.	$\tau - \tau'$ Fahrenheit.	Correction in Eng. feet.	$\tau - \tau'$ Fahrenheit.	Correction in Eng. feet.	$\tau - \tau'$ Fahrenheit.	Correction in Eng. feet.
°		°		°		°		°		°		°		°		°		°		°	
1.0	2.3	11.0	25.8	21.0	49.2	31.0	72.6	41.0	96.0	51.0	119.5	61.0	142.9	71.0	166.3	81.0	189.7	91.0	213.2
1.5	3.5	11.5	26.9	21.5	50.4	31.5	73.8	41.5	97.2	51.5	120.6	61.5	144.1	71.5	167.5	81.5	190.9	91.5	214.3
2.0	4.7	12.0	28.1	22.0	51.5	32.0	75.0	42.0	98.4	52.0	121.8	62.0	145.2	72.0	168.7	82.0	192.1	92.0	215.5
2.5	5.9	12.5	29.3	22.5	52.7	32.5	76.1	42.5	99.6	52.5	123.0	62.5	146.4	72.5	169.8	82.5	193.3	92.5	216.7
3.0	7.0	13.0	30.5	23.0	53.9	33.0	77.3	43.0	100.7	53.0	124.2	63.0	147.6	73.0	171.0	83.0	194.4	93.0	217.9
3.5	8.2	13.5	31.6	23.5	55.1	33.5	78.5	43.5	101.9	53.5	125.3	63.5	148.8	73.5	172.2	83.5	195.6	93.5	219.0
4.0	9.4	14.0	32.8	24.0	56.2	34.0	79.6	44.0	103.1	54.0	126.5	64.0	149.9	74.0	173.4	84.0	196.8	94.0	220.2
4.5	10.5	14.5	34.0	24.5	57.4	34.5	80.8	44.5	104.2	54.5	127.7	64.5	151.1	74.5	174.5	84.5	197.9	94.5	221.4
5.0	11.7	15.0	35.1	25.0	58.6	35.0	82.0	45.0	105.4	55.0	128.8	65.0	152.3	75.0	175.7	85.0	199.1	95.0	222.5
5.5	12.9	15.5	36.3	25.5	59.7	35.5	83.2	45.5	106.6	55.5	130.0	65.5	153.4	75.5	176.9	85.5	200.3	95.5	223.7
6.0	14.1	16.0	37.5	26.0	60.9	36.0	84.3	46.0	107.8	56.0	131.2	66.0	154.6	76.0	178.0	86.0	201.5	96.0	224.9
6.5	15.2	16.5	38.7	26.5	62.1	36.5	85.5	46.5	108.9	56.5	132.4	66.5	155.8	76.5	179.2	86.5	202.6	96.5	226.1
7.0	16.4	17.0	39.8	27.0	63.2	37.0	86.7	47.0	110.1	57.0	133.5	67.0	157.0	77.0	180.4	87.0	203.8	97.0	227.2
7.5	17.6	17.5	41.0	27.5	64.4	37.5	87.8	47.5	111.3	57.5	134.7	67.5	158.1	77.5	181.6	87.5	205.0	97.5	228.4
8.0	18.7	18.0	42.2	28.0	65.6	38.0	89.0	48.0	112.4	58.0	135.9	68.0	159.3	78.0	182.7	88.0	206.1	98.0	229.6
8.5	19.9	18.5	43.3	28.5	66.8	38.5	90.2	48.5	113.6	58.5	137.0	68.5	160.5	78.5	183.9	88.5	207.3	98.5	230.7
9.0	21.1	19.0	44.5	29.0	67.9	39.0	91.4	49.0	114.8	59.0	138.2	69.0	161.6	79.0	185.1	89.0	208.5	99.0	231.9
9.5	22.3	19.5	45.7	29.5	69.1	39.5	92.5	49.5	116.0	59.5	139.4	69.5	162.8	79.5	186.2	89.5	209.7	99.5	233.1
10.0	23.4	20.0	46.9	30.0	70.3	40.0	93.7	50.0	117.1	60.0	140.6	70.0	164.0	80.0	187.4	90.0	210.8	100.0	234.3
10.5	24.6	20.5	48.0	30.5	71.4	40.5	94.9	50.5	118.3	60.5	141.7	70.5	165.2	80.5	188.6	90.5	212.0	100.5	235.4

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TABLE III.—CORRECTION FOR DIFFERENCE IN THE FORCE OF GRAVITY IN DIFFERENT LATITUDES, +FROM 24° TO 45°,—FROM 45° TO 66°.

Approximate Difference of Level.	LATITUDE.											
	24° 66°	26° 64°	28° 62°	30° 60°	32° 58°	34° 56°	36° 54°	38° 52°	40° 50°	42° 48°	44° 46°	45°
Eng. Ft.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1000	1.7	1.6	1.5	1.3	1.1	1.0	0.8	0.6	0.5	0.3	0.1	0
2000	3.5	3.2	2.9	2.6	2.3	1.9	1.6	1.3	0.9	0.5	0.2	0
3000	5.2	4.8	4.4	3.9	3.4	2.9	2.4	1.9	1.4	0.8	0.3	0
4000	7.0	6.4	5.8	5.2	4.6	3.9	3.2	2.5	1.8	1.1	0.4	0
5000	8.7	8.0	7.3	6.5	5.7	4.9	4.0	3.1	2.3	1.4	0.5	0
6000	10.4	9.6	8.7	7.8	6.8	5.8	4.8	3.8	2.7	1.6	0.5	0
7000	12.2	11.2	10.2	9.1	8.0	6.8	5.6	4.4	3.2	1.9	0.6	0
8000	13.9	12.8	11.6	10.4	9.1	7.8	6.4	5.0	3.6	2.2	0.7	0
9000	15.7	14.4	13.1	11.7	10.3	8.8	7.2	5.7	4.1	2.4	0.8	0
10000	17.4	16.0	14.5	13.0	11.4	9.7	8.0	6.3	4.5	2.7	0.9	0
11000	19.1	17.6	16.0	14.3	12.5	10.7	8.8	6.9	5.0	3.0	1.0	0
12000	20.9	19.2	17.4	15.6	13.7	11.7	9.6	7.5	5.4	3.3	1.1	0
13000	22.6	20.8	18.9	16.9	14.8	12.7	10.4	8.2	5.9	3.5	1.2	0
14000	24.4	22.4	20.4	18.2	16.0	13.6	11.2	8.8	6.3	3.8	1.3	0
15000	26.1	24.0	21.8	19.5	17.1	14.6	12.1	9.4	6.8	4.1	1.4	0
16000	27.8	25.6	23.3	20.8	18.2	15.6	12.9	10.1	7.2	4.3	1.5	0
17000	29.6	27.2	24.7	22.1	19.4	16.6	13.7	10.7	7.7	4.6	1.5	0
18000	31.3	28.8	26.2	23.4	20.5	17.5	14.5	11.3	8.1	4.9	1.6	0
19000	33.1	30.4	27.6	24.7	21.7	18.5	15.3	12.0	8.6	5.2	1.7	0
20000	34.8	32.0	29.1	26.0	22.8	19.5	16.1	12.6	9.0	5.4	1.8	0
21000	36.5	33.6	30.5	27.3	23.9	20.5	16.9	13.2	9.5	5.7	1.9	0
22000	38.3	35.2	32.0	28.6	25.1	21.4	17.7	13.8	9.9	6.0	2.0	0
23000	40.0	36.8	33.4	29.9	26.2	22.4	18.5	14.5	10.4	6.2	2.1	0
24000	41.8	38.4	34.9	31.2	27.4	23.4	19.3	15.1	10.8	6.5	2.2	0
25000	43.5	40.0	36.3	32.5	28.5	24.3	20.1	15.7	11.3	6.8	2.3	0

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TABLE IV.— CORRECTION FOR—			TABLE V.—CORRECTION FOR THE HIGHT OF THE LOWER STATION:—*Positive.*						
Approximate Difference of Level.	Decrease of Gravity on a Vertical. *Positive.*		Hight of the Barometer, in English Inches, at Lower Station.						
	0	+500	16	18	20	22	24	26	28
Eng. Ft.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1000	2.5	3.9	1.6	1.3	1.0	0.8	0.6	0.4	0.2
2000	5.2	6.6	3.1	2.5	2.0	1.5	1.1	0.7	0.3
3000	7.9	9.3	4.7	3.8	3.0	2.3	1.7	1.1	0.5
4000	10.8	12.2	6.3	5.1	4.0	3.1	2.2	1.4	0.7
5000	13.7	15.2	7.8	6.4	5.0	3.8	2.8	1.8	0.8
6000	16.7	18.3	9.4	7.6	6.0	4.6	3.3	2.1	1.0
7000	19.9	21.5	11.0	8.9	7.1	5.4	3.9	2.5	1.2
8000	23.1	24.7	12.5	10.2	8.1	6.2	4.4	2.8	1.3
9000	26.4	28.1	14.1	11.4	9.1	6.9	5.0	3.2	1.5
10000	29.8	31.5	15.7	12.7	10.1	7.7	5.5	3.5	1.7
11000	33.3	35.1	17.2	14.0	11.1	8.5	6.1	3.9	1.8
12000	36.9	38.7	18.8	15.3	12.1	9.2	6.6	4.2	2.0
13000	40.6	42.5	20.4	16.5	13.1	10.0	7.2	4.6	2.2
14000	44.4	46.3	21.9	17.8	14.1	10.8	7.7	4.9	2.3
15000	48.3	50.3	23.5	19.1	15.1	11.5	8.3	5.3	2.5
16000	52.3	54.3	25.1	20.3	16.1	12.3	8.8	5.6	2.7
17000	56.4	58.4	26.6	21.6	17.1	13.1	9.4	6.0	2.8
18000	60.5	62.6	28.2	22.9	18.1	13.8	9.9	6.3	3.0
19000	64.8	67.0	29.8	24.1	19.2	14.6	10.5	6.7	3.2
20000	69.2	71.4	31.3	25.4	20.2	15.4	11.0	7.0	3.3
21000	73.6	75.9	32.9	26.7	21.2	16.1	11.6	7.4	3.5
22000	78.2	80.5	34.5	28.0	22.2	16.9	12.1	7.7	3.7
23000	82.9	85.2	36.0	29.2	23.2	17.7	12.7	8.1	3.8
24000	87.6	90.0	37.6	30.5	24 2	18.5	13.2	8.4	4.0
25000	92.5	94.9	39.1	31.8	25.2	19.2	13.8	8.8	4.1

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ANEROIDS.

The aneroid is a very convenient and useful instrument for measuring hights, but it is limited in its range of usefulness and it must be employed with the greatest care. It is an instrument that is often misused. It is applied to purposes for which it is by no means fitted, and it results from this that it has been discredited to a far greater extent than it deserves.

The principle upon which the aneroid works is similar to that of the cistern barometer, but it does its work by an entirely different species of mechanism. It is essentially an air-tight drum of very thin metal, corrugated in order to present a great surface to the air and to allow it to expand and contract freely. As the pressure of the outside air increases, the drum is necessarily contracted, and as the air pressure diminishes, the drum expands. The amount of expansion or contraction is multiplied many times by a chain of delicate mechanism, which finally ends with an index moving over a graduated circle. The motion of the index arm over this graduated circle shows, therefore, in greatly magnified form, the almost microscopic expansion and contraction of this drum. It can easily be seen, therefore, that it is an extremely delicate instrument and that the slightest causes may produce great errors.

Owing to its extreme delicacy the aneroid cannot safely be used for hight measurements unless it can be frequently checked upon known elevations, or by comparison with a cistern barometer. It can be used safely only for short intervals of time and for slight differences of altitude. An aneroid which measures differences of altitude, with a fair degree of accuracy, up to 1,000 feet, can by no means be trusted to record differences of 2,000, 3,000 or 4,000 feet. Though an aneroid be compared at the foot of the mountain both before and after the ascent, and show little or no change, it by no means follows that the hight of the mountain determined by reading it on the summit is correct.

The simplest way of using the aneroid is the best. The scale of feet, not that of inches, should be used. Starting with a point

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whose elevation is known, the scale of feet should be set to the known elevation and the elevation of other points measured during the day should be read off in feet directly, checking the aneroid on the return at night. It is not worth while to make any elaborate calculations based upon aneroid readings, for nothing will be gained by it.

DIFFERENCES OF ELEVATION BY VERTICAL ANGLES.

The equipment for this method of measurement of altitudes may be any instrument which is equipped with a vertical arc or circle and a spirit level. Instruments of this sort which would be within the reach of the members of alpine clubs, are commonly theodolites with arcs or circles reading to single minutes, or telescopic alidades connected with a plane-table, having similar arcs. To use this method it is necessary to do a little triangulation. A base line must be measured, or the distance between two accessible points must be known with some degree of accuracy. From each end of the base line a horizontal angle must be read between the other base stations and a point whose hight is to be determined. At each end of the base also a vertical angle should be measured to this point. The base line should run in a direction at right angles, or as nearly so as convenient, to the direction of the object whose hight is to be measured, and the ground over which it is to pass should be as nearly level as possible, in order to avoid errors in its measurement. This measurement may be made with steel tape or chain, as convenient, and care should be exercised to make it as accurate as possible. Its length should not be less than one-third or one-fourth the distance to the mountain summit, and its ends should be marked by signal flags. The summit of the mountain should also be marked by a signal, if practicable, unless this summit is sufficiently sharp to form a good target. The instrument should then be set up over each end of the base in turn and the angle between the other end and the summit of the mountain measured, together with the vertical angle to the summit of the mountain.

For the accurate measurement of vertical angles one adjustment

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of the instrument must be looked after carefully—that of the vertical collimation. The horizontal wire of the instrument must coincide with the line of sight of the telescope. To test this, train the telescope horizontally and note a point, at a distance, on which the horizontal wire falls. Then reverse the telescope, level it, and if it still points on this object, the adjustment is good. If not move the wire half way to the object and reverse again, repeating the operation until the wire falls on the same object in direct and reverse positions of the telescope. The adjustment of the spirit level must also be tested by using it in the direct and reversed positions, adjusting it in a similar manner, if found out of adjustment.

Immediately before or after reading each vertical angle the telescope should be set horizontally, i. e., should be turned until the bubble in the spirit level is in the middle of the tube and the reading of the vertical arc taken and recorded. This gives the index error, that is, the departure of the horizontal line from the zero of the vertical arc, and each vertical angle must be corrected for this index error. Great care must be exercised to avoid mistakes in sign in applying this correction.

The horizontal measurements make known, in the triangle formed by the two ends of the base and the summit of the mountain, one side and two angles. The other angle is, of course, then known, being the difference between the sum of the two angles at the base and 180 degrees. From these elements the lengths of the other two sides of the triangle can be computed from the formula, sin a: sin $b :: A : B$, or $B = \frac{A \sin b}{\sin a}$ Or, more simply, the triangle may be plotted by the use of a protractor, and the lengths of the two remaining sides measured from the plot.

After having discovered the lengths of the other two sides of the triangle, which are the horizontal distances from the ends of the base to a point beneath the summit of the mountain, we have for measuring its hight two right-angled triangles, the bases of which are these distances, and the angles at the base the two measured vertical angles. With these data we can solve these right-

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angled triangles by means of the formula, $h=A$ tang a, where h equals difference in hight between the two points; A, the horizontal distance between them, and a the vertical angle.

The difference of hight h may be either positive or negative, according as the point sighted on is higher or lower than the point occupied. This difference in hight must then be corrected for curvature and refraction. The former correction is due to the fact that a horizontal line from the point of observation is a tangent to the earth's surface at that point, and therefore the difference in hight which we have measured is not the difference as measured from the center or from the curved surface of the earth, but from this tangent line. It is necessary, therefore, in case the point sighted is higher than the one from which the measurement is made, to add to the difference in hight the amount by which this tangent line departs from the curved surface of the earth. The empiric rule for the curvature of the earth, which is sufficiently accurate for this purpose, is as follows: Curvature in feet equals two-thirds the square of the distance between the points in miles. This correction is positive, i. e., it is to be added when h is positive and subtracted when h is negative.

Refraction is a correction produced by inequality in density in different layers of the atmosphere. We see an object in the direction which the ray of light has when it reaches the eye. Now if that ray of light has been bent in its progress from the object to the eye, then we see the object in an incorrect position. All rays of light are bent to a greater or less degree. This bending or refraction is not uniform, but differs in different places and at different times of the day. It is generally greatest in the morning and afternoon, and least when the sun is highest. Sometimes and in some places it is extraordinarily great, producing mirage. This is especially the case in arid regions, while in regions where the atmosphere is charged with moisture the refraction is commonly much more uniform. It is therefore easy to see that refraction is an uncertain quantity and that any correction which can be applied is the merest approximation. It is commonly taken at one-sixth or one-seventh the curvature and has the negative sign, i. e., it is subtracted from h when that is positive, and *vice versa*.

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Instead of solving these right-angled triangles for obtaining the difference in hight between points, tables are commonly used for this purpose. A convenient form of table for such measurements as this is here reprinted (*Table VI.*). The body of the table gives the difference in hight for different vertical angles and distances, while appended to it is a small table giving corrections for curvature and refraction.

The greater the distance between the points whose relative hight is measured by this method, the greater the liability to error. An error of a minute in reading the vertical angle means an error of 1.53 feet in each mile of distance between them. Thus, if they be ten miles apart, such an error would give the elevation 15.3 feet in error. But of more consequence in this connection is the error or uncertainty due to refraction, which may assume great magnitude. It is therefore better to use as short lines of sight as can be obtained.

Finally, by way of applying the above, I would make the following suggestions concerning the method of measuring Mount Hood, which has not as yet, so far as I know, been measured in a trustworthy manner. A base barometer should be established at Hood River, and the elevation of its cistern above the track at the depot measured, the elevation of the track having been determined by R. R. levels. This should be read at regular intervals each day. The second barometer, after comparison with the Hood River instrument, should be hung up at Cloud Cap Inn and read there at the same hours with the Hood River instrument. Such observations continued for a number of days will give a good determination of the hight of Cloud Cap Inn. A third barometer, after comparison with these two, should be taken to the top of the mountain and there read at intervals of a half-hour or an hour during the stay of the party on the mountain, the barometer at Cloud Cap Inn being read at the same times. Of course the attached and detached thermometers should be read at each station with the barometers. The measurement of the summit of the mountain above Cloud Cap Inn, a difference of elevation of probably 5,000 feet, will be weak, owing to the great difference in altitude and the small number of coincident

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observations. This measurement I would supplement by vertical angles.

There is no good place in the neighborhood of the Inn for the measurement of a base line, but from the summit of Cooper's Spur a line can be measured westward up the spur of the mountain for a sufficient distance. From each end of this base line a point on the top of Cloud Cap Inn can be sighted upon and the distance computed. Vertical angles may be taken down to this point, and thus the elevation of Cooper's Spur, the east end of the base line, established. In this way the distance from Cloud Cap Inn to the to the summit of Cooper's Spur will become a new base line, and angles, both vertical and horizontal, can be taken from these two points to the summit of the mountain, its distance computed, and the difference of altitude obtained. By pursuing this plan I believe that the summit of the mountain can be determined with a probable error not to exceed 25 feet, and that without great expenditure of labor. It would, of course, be a great improvement on the plan here suggested if the hight of Cloud Cap Inn could be determined by spirit level from Hood River, as has been proposed.

United States Geological Survey, Washington, D. C.

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TABLE OF CORRECTIONS TO THE READINGS OF THE BAROMETER AT ANY TIME OF THE DAY TO REDUCE THEM TO A NORMAL MINIMUM.

PROF. GEORGE DAVIDSON.

The hourly range of the Barometer readings reduced to 32° Fahr. is derived from the *hourly* mean of the month *minus* the lowest hourly mean reading of the month. The barometer readings were reduced in 1850 from *hourly observations* at Girard College Magnetic Observatory, Philadelphia, Pa., Lat. 38° 59′ 17″; Long. 75° 10″ 4.″: From January 1, 1842 to June 30, 1845, excluding January, February, March, 1843; being 39 months. The mean reading for the above period was 29.932 inches: hight of cistern 112.3 feet above the mean tide of the Schuylkill River at Fairmount Water Works. The reduction to sea level, 0.124 inch, would give the mean reading 30.056 inches.

The lowest line shows the mean range from the lowest mean reading reckoned .000 at 16 hours.

	A.M. 0	1	2	3	4	5	6	7	8	9	10	11	Noon	1	2	3	4 16	5	6	7	8	9	10	P.M. 11	
January	.036	.036	.043	.045	.038	.036	.042	.056	.066	.072	.072	.056	.031	.006	.000	.004	.006	.015	.024	.038	.037	.038	.037	.034	January
February	.037	.036	.032	.026	.026	.028	.033	.039	.053	.059	.059	.056	.041	.018	.003	.000	.002	.008	.016	.024	.031	.038	.042	.040	February
March	.043	.037	.036	.024	.026	.031	.044	.052	.058	.059	.055	.048	.035	.020	.003	.000	.002	.013	.025	.040	.045	.054	.056	.061	March
April	.040	.036	.030	.029	.032	.040	.055	.066	.070	.070	.066	.057	.043	.030	.017	.007	.000	.004	.010	.019	.038	.043	.046	.051	April
May	.028	.022	.018	.020	.022	.035	.048	.058	.063	.062	.059	.052	.042	.031	.018	.007	.003	.000	.005	.015	.028	.041	.048	.051	May
June	.035	.026	.023	.024	.029	.039	.049	.057	.061	.060	.056	.052	.044	.032	.020	.012	.005	.000	.008	.013	.022	.029	.039	.039	June
July	.047	.039	.034	.030	.033	.042	.051	.061	.062	.060	.059	.053	.045	.043	.021	.010	.003	.000	.000	.005	.014	.018	.022	.025	July
August	.033	.028	.023	.020	.020	.028	.041	.050	.053	.056	.052	.049	.041	.030	.016	.007	.001	.000	.004	.011	.025	.032	.036	.036	August
September	.031	.027	.020	.019	.024	.031	.041	.050	.056	.061	.060	.052	.043	.026	.011	.001	.000	.002	.007	.012	.025	.036	.040	.037	September
October	.028	.027	.022	.019	.024	.033	.042	.053	.062	.063	.060	.051	.035	.016	.005	.001	.000	.006	.014	.025	.033	.040	.043	.043	October
November	.043	.041	.041	.040	.040	.046	.049	.058	.067	.070	.069	.056	.033	.013	.003	.000	.005	.013	.021	.032	.035	.036	.038	.035	November
December	.038	.037	.043	.044	.041	.041	.049	.056	.065	.070	.074	.051	.031	.010	.001	.000	.002	.008	.015	.022	.026	.027	.029	.030	December
Means	.037	.033	.030	.028	.030	.036	.045	.055	.061	.063	.062	.053	.039	.023	.010	.004	.002	.006	.012	.021	.030	.036	.040	.040	Means
	.035	.031	.028	.026	.028	.034	.043	.053	.059	.061	.060	.051	.037	.021	.008	.002	.000	.004	.010	.019	.028	.034	.038	.038	

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In the barometrical determination of differences of hight by means of the Aneroid in a general reconnaissance, it will be sufficiently close to assume that the normal lowest reading of the 24 hours occurs at 4 P. M. during the summer months. Then, in order to reduce all the field readings to this hour, subtract the numbers in the lowest line of the above table from the field readings for the normal difference in inches at 32 ° Fahr.

Of course it is understood that every aneroid barometer should be tested for its coefficient of temperature, notwithstanding it may carry the legend "compensated for temperature." The simplest method to determine this coefficient is (1) to read the barometer at the temperature of melting ice or snow (32° Fahr.) (2) so soon as practicable thereafter to read it at 132°; (3) and again at 32°. An extra precaution to check any barometrical changes in the intervals will be to read a second barometer not subject to change of temperature, at each of the test readings. The differences of readings for each 100° change of temperature will afford the correction for one degree, upon the assumption that the increment is regular.

San Francisco, Cal.

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MODEL TENT AND CAMPING OUTFIT.

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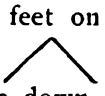
Description of a Model Tent and Camping Outfit.

CHARLES J. FOX, C. E.

[Many of the Mazamas and others who accompanied them at Crater Lake in 1896, saw and admired there a tent and camping outfit which seemed to them the most admirable for convenience, compactness and cheapness, that they had ever seen. It represented the condensed result of an enthusiastic camper's experience during some forty years. The owner of it, Mr. Charles J. Fox, C. E., of San Diego, Cal., afterwards furnished in a letter a description of the outfit, and a photograph of it, and has presented to the Mazamas a miniature exact model of the whole, which is to be seen at the society's rooms in Portland. The description, with such changes as were necessary to fit it for this publication, and an engraving made from the photograph, is printed herewith.—EDS.]

To make the Tent: The tent is 10x12 feet on the ground and 8 feet high at the ridge, and is of the  plan, being lighter, more roomy, easier to put up and take down, and safer in case of storm. The material is heavy brown denim, which comes 29 inches wide, and can be bought in the piece at from 12 to 15 cents per yard. I find it better than white duck for the following reasons: It is cheaper, more durable, and lighter; the brown color shuts out the light, is cooler when exposed to the sun, more inconspicuous, opaque when lighted inside, and does not show the shadows of persons dressing inside.

The construction is as follows—the width of the tent at the bottom being 12 feet, the height 8 feet, and the slope 10 feet. Take four widths of denim, each width 20½ feet long, and sew them together, lapping the selvedge edges half an inch flat with two rows of stitching. Make a tuck along the ends large enough for a rope about the size of an ordinary clothes-line, leaving about 2 inches of the cloth below it, finished with a hem. This rope is a "holt-rope" so-called on a sail. Sew to the hemmed edge a strip of gunny cloth about six inches wide, that may be made of barley sacks ripped open and cut in strips. This comes in under the tent, and on it is laid the floor carpet, making a snake- and rat-proof protection, the roof of the tent coming down to the ground on each side. In the center, where the roof of the tent rests on the ridge-pole, sew a chafing-piece 6 inches wide the whole length. For the ends, sew

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together as above enough widths to make 6 feet 6 inches wide, including a hem on the raw edge, and 8 feet 6 inches long. Cut it through diagonally of its length, leaving the narrow end 4 inches wide, the wide end 6 feet 2 inches wide, and the straight side 8 feet 6 inches long. This will furnish one half of each end of the tent. A similar one will make the other two halves, which must be alternated, so as to keep the same side of the cloth out. Make a tuck and hem on each end as on the roof part. Sew the diagonal or bias edge of each piece to the roof part with a double seam, leaving space between the seams for a holt-rope. The ends of the tent will lap over one another 6 inches, so a double set of strings to tie them together can be put on. A piece of the top can be turned down, so as to make a ventilator hole through which the ridge-pole of the tent will pass. Run a holt-rope through the tucks in the bottom, and one also down the gable, where the ends join the roof. Sew the strips of gunny cloth on all around the bottom, strings to fasten ends together, and extra ones on the outside to loop up the ends when the tent is open. Sew at each seam at the sides a short piece of rope, to fasten to a stake, and one at the middle at each end, and the tent is made. I cut out my own tent and my wife sewed it on her machine, and it cost us, with poles and all, $7.00, and has lasted us through four years of six months' camping each year. The poles are made as follows: Two pieces of tough, straight-grained wood 1x1¼ inches, and 10 feet 6 inches long, pointed at one end, and shod with a strip of strap iron. Three inches from the other end, a ¼ inch bolt fastens them together flatwise. This supports one end, and a similar one the other end of the ridge-pole, which is of tough wood, 1¼x3 inches, and 10 feet 6 inches long. This rests in the crotch of the supports, which are spread at the bottom the same width as the end of the tent, 12 feet; and the shod ends go a little way into the ground, so as not to slip. Of course the ridge-pole goes through the tent set edge-wise, is rounded on the upper edge, and notched near the ends, so as to fit in the crotch of the supports. Any one making the tent and poles would readily understand these details as they went along. When inconvenient to take along tent-poles, sapplings cut on the spot, and having forked tops, may easily be improvised for the end poles, while a rope pass-

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ing between two conveniently located trees may serve very well for the ridge-pole.

Having the end supports divided in this way, leaves the whole end of the tent open, supports it in case of wind, and, if guy ropes are run out from each end lengthwise of the tent, prevents it from falling down, even if all the pins come out of the ground in case of rain.

To put up the tent: Spread it on the ground with the bottom of each end fastened together; this will be 10x12 feet. Drive pins at each corner, and at the middle of each of the four sides, and tie the ropes to them. Run the ridge-pole through the ventilator holes near the top of the tent. Spread the end poles out nearly flat, lay the ridge-pole in the crotches, and raise each end gradually, one side at a time, until the poles are spread and the sides of the tent are stretched. Set the shod ends firmly in the ground.

A loop sewed to each end of the top and passed over the end of the ridge-pole holds the tent stretched; and a string sewed to the slope half way down, and tied around the end posts, keeps the sides stretched smooth. Loops can be attached to the ridge-pole inside, and a rope stretched lengthwise of the tent, to hang clothes on. A carpet made of oiled canvass, 10x12 feet, is very comfortable spread on the ground on top of the flaps.

After using all sorts of tent-pins, I have finally adopted the following. Take a piece of steel either flat, one inch wide and one-quarter of an inch thick, or, still better, of an oval shape three-quarters of an inch wide and one-quarter of an inch thick, and eighteen inches long. Have the end "upset" for an inch and welded. This makes a solid head for driving on. Have the other end drawn to a point. Half way between the ends have a hole punched through, but no iron cut out, merely spread, large enough to pass through the tie ropes at the bottom of the tent. In hard ground drive the pins half way down and pass the ropes through the holes; in soft ground drive clear down and make the ropes fast around the pins just under the upset. The pins can be carried in a small bag when traveling.

The Camp-wagon: The camping arrangements of the wagon

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are as follows. In place of the usual dash-board, is a box set on edge, with a door opening down, like a secretary, towards the horses, supported at the bottom by strap hinges, and when open supported at the other edge by small chains; when closed it is held in place by buttons. The inside is wide and high enough to hold square tin cans of one gallon each, like the common syrup cans, with loose lids. These are placed side by side, separated by little strips of wood, and each can labeled, coffee, flour, sugar, beans, fruit, etc., etc. Above these is a shelf, with room for the small flat tin boxes that crackers are sold in. Above this box is another with a lid which lifts up, being hinged at the front and right in front of the driver, so that he can reach it from his seat. This on my wagon is 6 inches deep, 7 inches wide, and about 3 feet long, and makes a very convenient place for ammunition and other small articles. Under foot I have a jocky-box for tools, etc., and above it on the side of the dash-board box, facing me, are hooks to hang guns and fishing rods on. Under the seat I have a box for clothing.

At the back of the wagon I have a mess chest. Both sides let down like that of the box at the front of the wagon, so as to make a table on each side. There are staples at each end which admit of legs being inserted, flaring outward for stability; or the legs can be taken out and the box closed and set in the wagon, being just long enough to fit in the back of the wagon.

Under the rear of the wagon, close behind the axle, is a light box covered with canvas, to carry cooking utensils in. A small sheet-iron stove, being a box with no bottom, to set on the ground, makes the cover of the carrying box. The stove is 8 inches high, 12 inches wide, and 20 inches long. At one end is a door hinged at the top, and near the other end a half-round hole for a stove pipe made in two joints, which taper, telescope together and pack in the box. A small windlass of ¼ inch iron rod winds up leather straps that support the box, and it is further secured by safety straps hooked into snaps.

At the sides of the wagon are hooks that carry the tent poles, also a bucket for the camp, an axe, and other little conveniences too numerous for description, the result of long experience.

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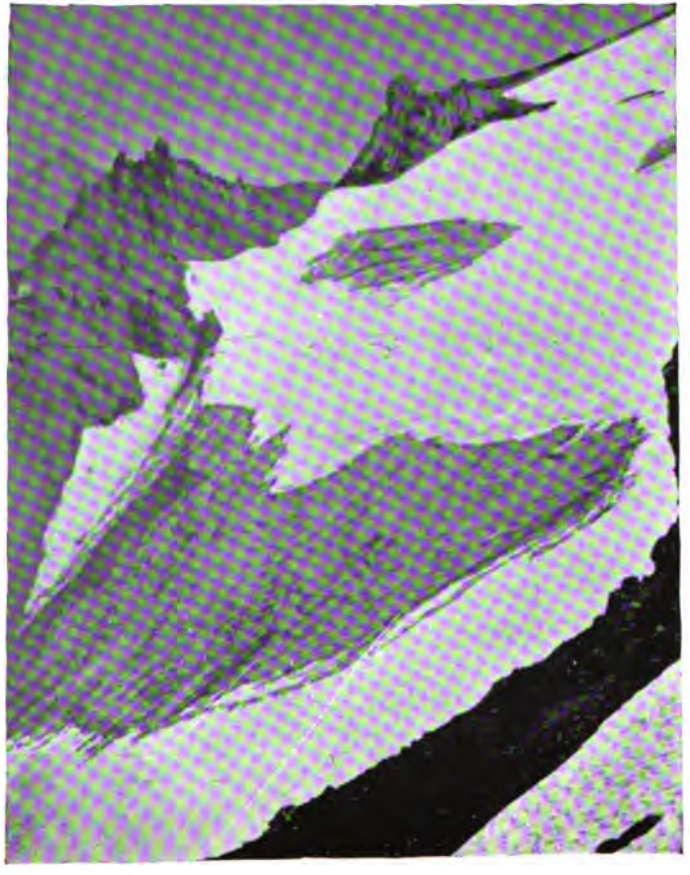

Photo. by B. W. Evermann.

SHOLES GLACIER, MOUNT PITT.

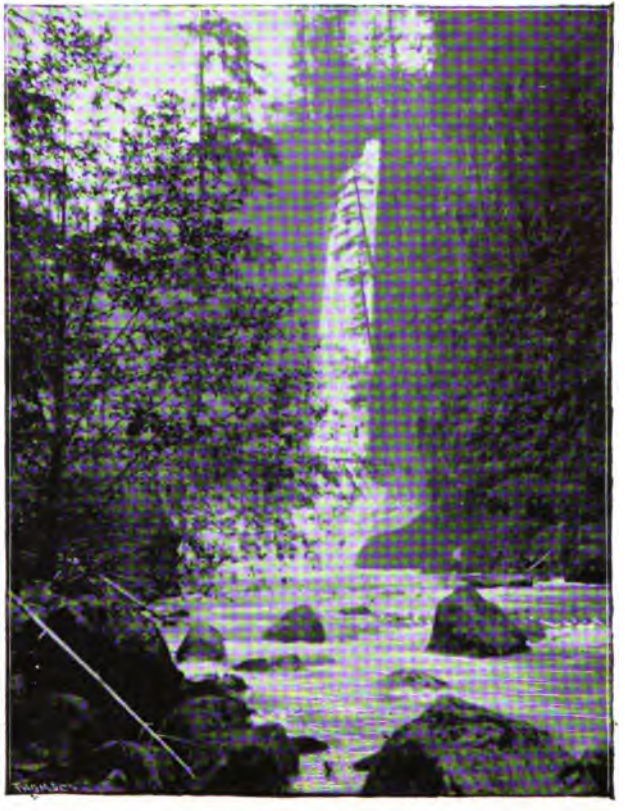

Photo. by C. C. Lewis.

MILL CREEK FALLS.

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Perhaps the engraving will give a better idea of the whole outfit than can be written. It shows the full front of the tent tied open, as it is generally used, and shows how commodious it is, having no pole either in the door or in the center of the tent to be in the way. The front of the wagon is shown with the provision box open, showing the cans for stores. The mess chest is shown mounted on its detachable legs, with both sides let down, thus converting it into a table on each side. The stove is shown as set up ready for use.

San Diego, Cal.

Historian's Report for 1896.

T. BROOK WHITE.

Of the three historians who have had the honor to report to you, it has unfortunately happened that two have been unable to participate in the annual outing. The outing at Crater Lake must be described in detail by another pen than my own, but it is well that the other events of the year should not be eclipsed and allowed to go unrecorded. The main contributions of 1896 to our history, in addition to the pilgrimage to Crater Lake and naming of Mount Mazama, are the lectures of Mr. Grant, Joaquin Miller, and Dr. Merriam, the publication of the first number of our bulletin, the distribution of certain maps, the ascent of Mount Pitt, and the ascent and council meeting on Mount Hood in honor of our anniversary.

Mr. Grant's lecture was very thoroughly advertised, good business methods were pursued, and much tact used in enlisting the co-operation of a large number of people; the result was a decided suc-

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cess in every respect, and a net gain to both the lecturer and the society of a considerable sum. It is probable that if the same methods had been pursued in regard to Joaquin Miller's lecture the result would have been equally satisfactory. Dr. Merriam's lecture was of a different order. He kindly gave his services gratuitously, the expenses being borne by a few individuals in the society. Dr. Merriam is one of the highest authorities on biology in the country, and both here and at Crater Lake has placed us under a great obligation to him, fittingly recognized by his nomination for the highest honor we can bestow.

The publication of the first number of the Bulletin marks a distinct advance in our progress. When Mr. Walcott, Director of the U. S. Geological Survey, was here, in answer to my request for certain government publications for the society he at once asked: "Do you publish?" Provision is made for exchange of many official publications which are not distributed gratuitously. Although I was one of the committee on publication, business took me away at the most critical time, and I can therefore congratulate and compliment my fellow members on the able way in which their work was performed. Three maps have been gratuitously distributed to members. One was largely devoted to Mount Hood, and is the first attempt to depict its glaciers, and to show what streams are fed by them. It was compiled by the gentleman since appointed Surveyor General of the State, from notes and sketches furnished by members of this society. The other two were both published by the Geological Survey, the special Crater Lake sheet being published at our request made through our representatives in Congress, but for which we also recognize our indebtedness to Mr. Diller.

The liberal concessions made to the society, by all from whom they have been asked, shows that these people are intelligently alive to their own interests and appreciative of one of the prime objects of our existence as an organized body, "the dissemination of knowledge concerning the beauty and grandeur of the mountain scenery of the Pacific Northwest." Hotels, railroads, steamer lines, stage lines, and mountain resorts have in every case readily granted what has been asked of them; the reductions to members of the society in good standing are liberal, and the benefit to the individuals, great.

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It is a common thing in most societies for the governing body to fail to transact business because of "no quorum," but when our secretary issued a call for the Council to meet on the summit of Mount Hood in celebration of the anniversary of our organization, a majority of the Council duly met, and 20 new members were then and there elected. Another meeting of the society was held later on in the crater or Witches' Cauldron in the middle of Crater Lake, and 14 more names added to our list of members. Forty years ago Winthrop alluded to Mount Rainier as a mountain which would forever remain a virgin peak, and would never be sullied by the foot of man. But if, as I hope may be the case, it is decided that our next annual outing shall be there, and a council meeting is called for its summit, a quorum will be there. In fact, if the United States wants the honor of the discovery of the North Pole, all it has to do is to request our secretary to call a meeting of Mazamas there, *guaranteeing all expenses*, and the necessary quorum for the transaction of business will be on hand.

In accordance with the amendment adopted at the last annual meeting, consuls were appointed to represent us in the various cities in which they resided. Our consul in Washington was fortunately our first president, Mr. Steel. His labors on behalf of the preservation of the Cascade Range Forest Reserve, his enlistment of the cooperation of the several specialists, who contributed so greatly to the interest and enjoyment of the expedition to Crater Lake, are but a small part of the work he accomplished for us there.

The outing of the year at Crater Lake, on Mount Mazama, will live in the memories of those who participated in it as one of the chief events of their lives. The presence of an eminent geologist, a biologist, a botanist and an ichthyologist, each of whom delivered an address to the crowds gathered around the camp fires, made the outing one of peculiar scientific interest. Their lectures have fortunately been preserved for publication in the next number of our Bulletin, and will add greatly to its value. It was definitely ascertained that Crater Lake is sufficiently well supplied with insect life to justify the introduction of fish, and arrangements have already been made with the U. S. Fish Commission for a supply to stock

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it. Another fact, ascertained by Prof. Evermann, is that the water of the Lake is perceptibly warmer in its greater depths, indicating the existence of volcanic heat, an interesting though not surprising fact, as there is a very considerable degree of heat left in each of our volcanoes.

Before concluding this already lengthy report, there is one subject to which I take leave to allude—the recent fate of the despoiler of Indian graves at the hands of the outraged descendants of the dead. All nations respect the graves of their ancestors, and the more primitive and less progressive races carry the feeling of respect and veneration to even a greater length than the more advanced. Our own Riverview Cemetery is the most familiar example of the form in which this feeling finds expression among us; but of all the burying places I have ever seen, Riverview, Greenwood, the tomb of Grant on the Hudson, or of Napoleon in its beautiful crypt, Westminster Abbey, those "miracles in stone" the pyramids, none are more beautiful or expressive of the silence and rest of the dead than the island in the Columbia above the gorge, and marked by the tomb of Vic Trevett, which from time immemorial the original inhabitants of this country, generation after generation, have used as a burial ground. I have often wondered whether Bryant was aware how much truth was expressed in his "Thanatopsis," when referring to this very river he says, "the dead are there." Its most picturesque islands, as well as scores of others in lakes hidden in the deepest recesses of the forests, are old Indian burial grounds piled with the bones and dust of countless thousands.

Imagine for a moment the feelings of the people of this city were it known that some individual, and especially an Indian or Chinaman, was making a regular practice of opening graves at Riverview and robbing the bodies of the dead of the trinkets buried with them. Can it be wondered, then, that, when the few remaining survivors of the great tribes whose chiefs and ancestors are buried on these beautiful islands learn that these ancient cemeteries have been desecrated for the sake of the few arrow points, glass beads and trinkets which the graves contain, all their most savage instincts are inflamed, and that when finally the despoiler of graves

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is caught in the act, he is tortured to death after the ancient custom of these tribes. A sort of poetic justice overtook this man, but his death may and I trust will be the means of causing these old historic cemeteries to be taken under the protection of the laws of the State and of the United States.

Too much work has hitherto been concentrated on one or two officers, and I speak feelingly and from experience for the overworked secretary. This can be greatly relieved by the appointment of standing committees. In order that this report may not be entirely *cultus wa-wa*, but may have a practical side to it, I venture to suggest that a standing committee on legislation be appointed and that they be instructed to prepare a bill for introduction in the next legislature protecting these old Indian burying grounds.

Two other excellent suggestions have been made, one by my predecessor, Mr. Gorman, the other by Dr. Merriam. The first was to protect the records, instruments, and shelters, which are now or may hereafter be established for the benefit of the public on mountain tops and elsewhere. The second was Dr. Merriam's suggestion that by the contribution by the State of a small percentage of the expense, the U. S. Government would defray the greater part of the cost of the survey and publication of accurate maps of the State, which would be of inestimable value in its development.

I trust that each of these three suggestions may take practical shape in the hands of the Council, and that another year will see Indian graves and mountain records protected and the publication of maps provided for.

Portland, Oregon, October 5, 1896.

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President's Address for 1896.

C. H. SHOLES.

In submitting this third annual address I cannot suppress a feeling of enthusiasm as I contemplate the results of our labors the past year—a feeling in which, before I conclude, I trust those will share, if any there be, who have felt anywise doubtful of the growth and perpetuity of our society. The crucial year is passed. The time when the paid-up membership was confined to the officers and a few enthusiastic associates is happily over, and we now have out of the entire number who joined, first and last, a paid-up membership of about 120, a goodly number of whom may be considered working members. To have retained so many old members, and gained so many new ones, in the midst of an unexampled financial depression, is a subject for congratulation, and speaks volumes for the present strength and future prosperity of a society that is destined to take high rank among the leading Alpine societies of the world. In the very nature of things our membership must be limited in number; some people cannot, and others will not, climb mountains. And herein lies its greatest strength, because in either event a sifting process, unprecedented in its application, tends to guard our society from all elements of weakness or disaffection. All that it now needs to spur it on to still higher achievements is your unflagging interest and devotion, not only with your alpenstock in the outing season, but with pen and purse and voice throughout the year. Within two years the name *Mazama* has been heard throughout the world, and to-day it stands as a synonym for all that is unique, progressive and inspiring in mountaineering societies. But dangers lurk in such phenomenal success, and it behooves us to distinguish between popular notoriety, and the calm judgment of history which only weighs and rewards results, lest, becoming enamored of a transient reputation, our society sink into an early and deserved obscurity. Our scientific work of the past two years, while indicative of intent rather

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than results, has nevertheless been of sufficient promise to have made for us a position as honorable as it is encouraging; but it will not do to halt upon laurels already won, while broad and interesting fields of recreation and scientific inquiry beckon us on.

By the publication of the first number of an annual bulletin, a distinct and noteworthy advance was made, and the effect on the strength and popularity of the society was immediate. "Mazama" has been before you and has spoken for itself; but it may please you to know that in the estimation of many disinterested critics and scientific men it is worthy to rank with any similar publication. The next issue (the early publication of which will depend upon the prompt payment of annual dues) will be devoted to Crater Lake and Mount Mazama; and while the details concerning contents and publication will be in the hands of the new Executive Council, I violate no confidence in saying that all the scientific gentlemen whose presence and talks added so much to the interest of our Crater Lake expedition have consented to prepare articles for it, and from the foretaste given us at that time I do not hesitate to say that the Crater Lake number of "Mazama" will be of surpassing interest and value.

In addition to the publication of the bulletin, there were distributed to members a new map of Mount Hood, a local publication, and the Ashland sheet of the United States Geological Survey, a contour map of the Crater Lake region. There was also sent to members through the generosity of Mr. J. S. Diller, of the Geological Survey, an illustrated edition of the Crater Lake special sheet containing a description of the Lake by Mr. Diller—a map of very great value to all desiring accurate knowledge of that wonderful region. During the months preceding the summer outing, several circular letters to members were put forth by the secretary, which were instrumental in keeping them in touch with the work of the society, and served well to keep alive their interest in it.

The work of the publication committee and the numberless details of writing and mailing circulars, delivering maps, bulletins, etc., largely devolved upon the secretary; and I should feel that I had omitted a duty and denied myself a pleasure if I failed to bear

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testimony to the efficiency of that officer and the admirable work he has done in the past year, to whom more than to all else, is due the present financial strength of the society. Only those who have been in a position to know can readily appreciate the immense amount of work he has done, and its value to the society. The secretary's work, so all-important to the vitality of a society like this, falls naturally into two divisions: (1) correspondence, much of it with government officials and scientific societies, writing of circular letters to members, preserving a concise and accurate record of meetings of the society and of the Executive Council, preparing announcements of meetings, outings, etc.; (2) mailing of circulars, bulletins, collecting dues, keeping accounts, etc.; in other words, literary and manual. The first requires more than ordinary literary ability and judgment; the second can be done by any careful business man or woman. To put upon one person all the labor which that office is now required to perform in order properly to administer the affairs of this society is unjust, even if it were possible in such circumstances always to secure a competent officer. I therefore suggest for your consideration whether an assistant secretaty should not be provided for.

Considerable work was done by the Executive Council during the past year, ably assisted by Mr. W. G. Steel at Washington, toward preventing the restoration of the Cascade Range Forest Reserve to public sale and entry, and securing the enactment of better laws by Congress for its preservation and control. The thanks of the Executive Council are also due United States Judge Bellinger and Hon. John B. Waldo for many valuable suggestions in the prosecution of this work. This is a matter of vast importance to the people of Oregon and Washington, and the work is one which this society can materially assist in doing, and which in the absence of a State Forestry Association naturally falls upon us to do. It is largely a work of education and the enlightenment of public opinion, since an intelligent person only needs to give the subject a cursory examination to become convinced of the wisdom, if not the necessity, of maintaining the reserve in its present limits practically intact.

To those who took part in the Crater Lake expedition it is

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superfluous to say that it was an unqualified success. About forty Mazamas attended (joined at the Lake by several hundred people), making a journey of nearly 900 miles, 180 of which was by means of ordinary mountain conveyances over good, bad and indifferent mountain roads; and yet, every day for three weeks was full of interest and charm, unmarred by a single incident or disappointment. The long days' marches through the broiling sun; pitching the nightly camp, followed by happy hours around the evening camp fire, now enlivened by songs, recitations and stories, and anon the club yell or far-sounding yodeling of the mountaineer awaking the echoes; trail making to Mount Pitt, a night without water at Rocky Camp; the successful ascent of a party of thirty to the summit of Pitt; the hurried return on half-rations, and the glad reunion at Pelican Bay, where the famished party was feasted; the arrival at the Lake; the enthralling effect of its beauty, mystery and grandeur; the visits to Wizard Island; the scientific symposiums around the campfire; the interesting ceremonies of Mazama day; and lastly—most remarkable of all—this inimitable aggregation of scientist, student, artist, explorer, health-seeker and mirth-provoker, of wild jollity, exuberance and irrepressible good nature, all mingled day after day and kept in unceasing turn without one crank, are themes for the Historian's pen, and are only briefly mentioned here to revive for a moment some of the exquisite memories of the never-to-be-forgotten Mazama excursion to Crater Lake.

Whether due to the influences of our society or not, the fact must have been observed by you all that the spirit of mountaineering in Oregon and Washington has lately exhibited a remarkable growth. Of more than 800 persons who have ascended to the summit of Mount Hood since 1853, I learn from the secretary that over 600 have made the ascent since the organization of the Mazamas. A similar proportion holds true with reference to Mounts Adams, St. Helens, Jefferson and Pitt. But the number of those who climb to the summits of those great peaks, compared with the number who seek the mountains as pleasure and health resorts, spending from ten to thirty days in the fish and berry altitudes, is very small; so that, according to the best information, we can safely say that this year,

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in Oregon alone, several thousand people have gone to the mountains for their vacation. The beneficial effect, morally, intellectually and physically, of these annual pilgrimages is beyond calculation. The mountains are the ideal playgrounds of the world, affording recreation for the tired brain as well as for the tired body. They appeal to the imagination more powerfully than any other natural wonder ever has, and unenviable indeed is the lot of one who does not find himself unconsciously uplifted and ennobled, as well as physically improved, after a week's sojourn among the mountain solitudes. Prof. Tyndall, who made annual visits to the Alps, thus writes of their health giving power:

"I lingered for nearly three weeks among the Bernese and Valasian Alps. This time, however, was not wasted. It was employed in burning up the effete matters which nine months' work in London had lodged in my muscles—in rescuing the blood from that fatty degeneration which a sedentary life is calculated to induce. I chose instead of the air of a laboratory that of the Wetterhorn, the Galenstock, and the mountains which surround the Great Aletsch glacier. Each succeeding day added to my strengh."

Again says this clear-sighted scientist: "There is assuredly morality in the oxygen of the mountains, as there is immorality in the miasma of a marsh, and a higher power than mere brute force lies latent in Alpine mutton. We are recognizing more and more the influence of physical elements in the conduct of life, for when the blood flows in a purer current the heart is capable of a higher glow. Spirit and matter are interfused; the Alps improve us *totally*, and we return from the precipices wiser as well as stronger men."

The time when the tide of American pleasure travel which has hitherto swept through the Alps shall turn to the mountains of the Pacific Coast may be safely limited, I think, to the building of good roads and comfortable accommodations within what are now, to the tourist class, practically inaccessible regions. It will be some time before this is fully accomplished, and it is a work which does not come within the scope of our society; but there are important and extensive lines of work, strictly within our province, which must appeal to every mountain-lover, and ought to be prosecuted with intelligence and zeal, against the time when our Good Roads Clubs shall have Mount Hood and Mount Mazama, and the intervening peaks, connected by a system of superior modern highways. I refer to the publication of maps and guide-books to the various snow-peaks, and the naming of the more prominent unnamed features of

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the landscape. The subject of guide-books has been incidentally discussed by the present Council, the importance of immediate action recognized, and plans suggested, but not yet matured, for the beginning of the work. As the importance of the latter suggestion is not so apparent, perhaps a few words regarding it may not be inappropriate at this time.

The dawn of civilization began with a name. The intelligence and culture of a people are measured by their language, and their progress in science, in literature and in the arts may be unerringly traced by the growth of their vocabulary. The deserts of intellect and the deserts of sand are alike in the poverty of their names. Comparing a map of the Alps with the best existing map of the Cascade Range in Oregon, the tourist would say to himself, The former exhibits a thousand points of interest to one in the latter, I will go to the Alps. And yet, we know that between the Columbia river and Mount Mazama there are snow-peaks, glaciers, canyons, gorges, vast forests, lakes, rivers, lofty falls, natural bridges of solid rock, hot, cold and mineral springs, in short, an inexhaustible aggregation of physiographic features of interest to scientist, artist and health and pleasure-seeker, although, excepting a few of the more important and familiar ones, we can only designate them in general terms. That this is a most serious disadvantage, ever increasing with the increase of tourist travel, let those testify who have been compelled to confess the humiliating fact to strangers. If some portion of the mountain range, for example, stands out so as to be a marked feature of the surrounding group, why should it not have an individual name? There are many such minor peaks within view from Portland, and although coeval with Mount Hood, they are like unnamed babes in that, so far as history is concerned, they have not yet entered upon their career. Humanity may ebb and flow around them, tragedy and romance may stain with blood and tinge with beauty their rugged heights; but until named they can take no permanent place in song or story. The literary, artistic and human interest each demands the gift of names to the unknown peaks, the lowly hills, the gloomy canyons, and sequestered lakes. On the other hand, the *ex cathedra* giving of names by an individual or a

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society is a delicate matter, and might easily result in placing Oregon, now so fortunate in this respect, alongside the State of New York, which is said to have the most ridiculous collection of geographic names on the map; and I do not wish to be understood as advocating any such attempt. But there is much to do that, if done in the true scientific and literary spirit, will not only redound to the honor of our society and perpetuate its memory as long as language lives, but be of great historical value to the State. I believe it is acknowledged by all historians that the preservation of the names of aboriginal tribes, by attaching them to the geograpical and physical features of the country, is not ouly useful in perpetuating history, but is a simple act of justice to a people which are fast perishing from the face of the earth. Rev. Roland D. Grant told me that he had discovered over 220 distinct tribal names belonging to Indians at one time living in Oregon (then comprising also Washington and Idaho). In no State in the Union is there such wealth of material, both of names and of unnamed objects; and I take the liberty of suggesting to the new Council the advisability of a standing committee on names, to whom shall be admitted all offerings of that kind from members.

Those of you who attended the Mazama excursion to Mount Adams a year ago will remember seeing from Trout Lake camp, when looking northwest through the White Salmon gap, particularly when the horizon was radiant with the golden splendor of the setting sun, the seeming outlines of a human face and breast, as of a giant in the sleep of death. Stern and bold in outline, it seemed to add a profound human interest and significance to an otherwise ordinary mountain landscape. So striking an object attracted the attention of the camp, and its resemblance to the Indian features was commented upon by many. What could be more suitable than to give to this image, sculptured by the slow processes of the geologic ages, the name of some old Sachem of a tribe that in prehistoric times slew the wild beast upon its breast, and which but for its chieftain's name would now be buried in oblivion. This is where Nature and Poetry meet; and when a Hawthorne cements the union with his magic pen, a spring of romance gushes forth, and we have that marvelous tale, "The Great Stone Face."

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In closing this subject I beg your indulgence to quote a few lines from one who has expressed my thought more completely than I could do myself. Susan Fenimore Cooper, daughter of the first American novelist, writes as follows:

"There are many reasons for preserving every Indian name which can be accurately placed; generally. they are recommended by their beauty; but even when harsh in sound, they still have a claim to be kept up on account of their historical interest, and their connection with the dialects of the different tribes. A name is all we leave them, let us at least preserve that monument to their memory; as we travel through the country, and pass river after river, lake after lake, we may thus learn how many were the tribes who have melted away before us, whose very existence would have been utterly forgotten but for the word which recalls the name they once bore. * * * * * That the names of men honorably distinguished should occasionally be given to towns and counties, or to any mark drawn by the hand of society upon the face of the country, would seem only right and proper; but except in extraordinary cases growing out of some peculiar connection, another class of words appears much better fitted to the natural features of the land, its rivers, lakes and hills. There is a grandeur, a sublimity about a mountain especially, which should ensure it, if possible, a poetical or at least an imaginative name. Consider a mountain peak, stern and savage, veiled in mist and cloud, swept by the storm and the torrent, half-clad in the wild verdure of the evergreen forest, and say if it be not a miserable dearth of words and ideas to call that grand pile by the name borne by some honorable gentleman just turning the corner in honest broadcloth, close buttoned to the chin."

Mazamas, our society is about the enter upon another year of life. Whether it shall be one of progress and achievement commensurate with its past proud record is for you to say. One thing is sure, it must have the untiring support of every member if it shall continue to advance and annually respond to the high ideals it has itself established. Its demands upon members are small, and while those duties may be discharged in a half-hearted and perfunctory way, I entreat you to remember that it is only through the fidelity and loyalty of those who proclaim themselves, "Once a Mazama, always a Mazama," that its future successes can be won.

Portland, Oregon, October 5, 1896.

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Note and Comment.

[The Publication Committee will be glad to receive from members and others material too short or too informal to make extended articles for the body of "Mazama," and to publish them, if thought suitable, in this department. Notes of early or recent explorations, geographical notes, outlines of little-known trails or routes, or references to interesting features in the mountains not generally known of, will be especially welcome].

The publication of this number has been unexpectedly delayed, for reasons which it seemed difficult to prevent, to very far beyond the date originally set. The next publication committee, however, hope to have their number well under way at an early date.

On the Mazamas' annual outings a cheer is indispensable. Several different ones have been used informally, and are known to the members. The following one was proposed during the outing of 1897, and gained some currency:

"Three cheers for the mountaineers,
'Rah! 'Rah! 'Rah!
Nesika klatawa sahale,
Ma-za-ma."

The words in the third line have been informally considered the motto of the society, though never regularly adopted by it, and appear upon its "coat of arms," or seal, as shown on the cover of this publication. They are from the Chinook Jargon, the inter-tribal language of all the Indians of the North Pacific Coast, and mean, literally, "We go up."

The feature which makes Mazamas quite unique among the Alpine clubs of the world, and makes membership in it a distinction not easily to be had, and highly prized by members, is the provision of the Constitution that only those shall be eligible to membership who have climbed to the summit of a snow-peak acceptable to the society. No list of "acceptable peaks" has been attempted to be made, and the case of each applicant is considered by the Council independently on its merits. But the policy thus far followed has been to consider no peak acceptable if less than about 10,000 feet high, to accept no

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peak in the Pacific Northwest, at least, not bearing a glacier, and no peak, of whatever hight, to the top of which (as Pike's Peak) one can ride. Membership is restricted closely, therefore, to those who have proved themselves mountaineers by hard-won personal experience. The standard of admission in future is more likely to be raised than lowered.

There are current in the Pacific Northwest numerous vague traditions of eruptions of its different snow-peaks within the memory of man, but it is usually so difficult to get at anything definite or authentic on the subject, that the following letter will be read with especial interest for its authentic character. The letter is furnished by Prof. George Davidson of San Francisco, and the writer was for many years physician and factor of the Hudson Bay Company at Nisqually, Wash.

CLOVERDALE, B. C., Box 226 P. O.,
VICTORIA, 13 Feb., 1886.

MY DEAR GEORGE DAVIDSON:

Your favor of Jan. 13 last is before me. I remember in some of the early forties hearing of a strange cloudiness in the neighborhood of St. Helens, *La win althla* the Yakima name, and that quantities of ashes, white if I rightly remember, and light, had soon after been found on its slopes and in the woods around its westerly base.

That from Nisqually I noticed this smoke I cannot recall to mind; but as to having heard of it I have no doubt. Cannot some of your young stalwarts of San Francisco be induced next September to ascend St. Helens, if possible to its summit, and look for signs of eruption within the last four or five decades. In the *Whulwhai pum* or Klickitat, a closely cognate language, or rather dialect to the Yakima, *nawinata* means thunder, and it has long ere now occurred to me that the mountain had in the dim past got its native name from rumblings, as of distant thunder, sounding from its inwardness, perhaps with smoke and more fiery accompaniments. Some intelligent and accurate man in the Yakima valley might investigate for you. I know of none to suggest by name.

Shall try Catholic priests once in Yakima now at N. Westminster, B. C.

Yours ever,

W. F. TOLMIE.

A propos of the article in "Mazama," No. 1 page 98, on "The Glaciers of Mount Adams," Mr. C. E. Rusk, of Blockhouse, Wash., writes that he with a party of two others went clear around Mount Adams in 1890, completing the circuit in eleven days, and visiting not only the Klickitat glacier, but nearly every other of the many

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glaciers on the mountain. The party found an immense glacier just north of the Klickitat glacier on the east face of the mountain, equalling or exceeding the Klickitat glacier in size, and christened it the "Rusk glacier." The two glaciers empty into what Mr. Rusk has named Avalanche Valley, from the great number of glacier avalanches occurring on that side of the mountain.

Mr. Rusk also communicates the following interesting note on the source of the Klickitat river.

"The impression that Klickitat Glacier is the real source of Klickitat river is an erroneous one. The waters of Klickitat, Rusk and Mazama glaciers, uniting far below the timber line, form what is locally known as the Little Muddy. The Little Muddy flows eastward and, several miles from Mount Adams, pours into the lickitat river, which at this point is already a large stream. Some miles above the mouth of Little Muddy the Klickitat forks, about the same amount of water flowing in each branch. The west branch comes from the north of Mount Adams where, I think, it has its source in a chain of lakes. It also receive the waters of the glacier of the north and northeast slopes of the mountain. This stream is generally called the Big Muddy, although confusing regarding the Big and Little Muddy, often arises.

The Klickitat proper, still flows from the north and has its head in a group of rugged, glacier-bearing peaks, nearly midway between Adams and Rainier; perhaps a little nearer to the latter. These peaks are most commonly called the Goat Rocks, from the great number of 'mazamas' that frequent them; although various other names have been applied. The Tieton and the Klickitat rise very near each other on opposite sides of a sharp watershed; the former flowing off to the east to join the Yakima, while the Klickitat flows southward to the Columbia. The Cispus also has its source in this region and there are many smaller streams that eventually go to feed the larger ones. The country around the head of the Klickitat is one of the most delightful portions of the Cascades."

The Mazamas propose to publish lists of climbers of all the Northwestern snow-peaks from time to time, as opportunity may arise, bringing the record down at least to the time when permanent boxes and record books are placed on the several summits. It will hardly be practicable to continue the lists as they are increased from year to year, now that so many hundreds ascend each season. But the names of the climbers during the early years—the pioneers in mountaineering in the Northwest, deserve publication. Names of later climbers can be consulted in the record books either while kept on the summits, or after removal from there for preservation in the archives of the society. It is sad to be compelled to report that some unknown vandal has removed or destroyed the record book placed by the Mazamas on Mount Adams in 1895.

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The following corrections or additions to the lists previously published are made:

To the Mount Hood List:

For Casto, Charlet C., *read* Charlotte C.
Omit Eastham, Jessie.
For Cooper, Mrs. J. S , *read* Mrs. Jennie.
Omit Gifford, Benjamin A.
Add to Krupke, Mary, the date, 1895.
" Moulton, E. C., " " 1895.
For Ohmart, Adam, 1864, *read* 1894.
Add to Northrup, H. E., the date, 1895.
Omit Ortschild, Viola.
Add to Randall, Adelia M., the date, 1895.
" Roberts, Anna M., " " 1894.
" " Daniel H , " " 1894.
" Seeley, Lamar B., " " 1895.
" Robinson, Robert, " " 1895.
Omit Robertson, F. M.,
For Sherrar, *read*, Sherar.
Omit Summers, Mattie
For Travaillot, O., 1853, *read*, 1854.
" Wood, Prof., *read*, Prof. A.

Add the following names:

Albright, Edward F., Portland 1865
Daily, Peter, Portland.....1865
Ellis, Cleora, Portland.....
Fisher, Mr., Portland. .....
Hague, Arnold, Washington, D. C. 1870
Hunsaker, Jacob, Oregon City.....186–
Myers, Albert G., Portland.....1859
Patterson, William F., Portland...1865
Reynolds, Byron, Portland.....
Routledge, Frank C , Portland.. ..1894
Shedd, Jacob, Portland... 1865
Straight, Hiram, Oregon City.....186–
Welch, Thaddeus, Portland 1865
Wilson A. D., Washington, D. C....1870

To the Mount Adams List:

For Eliot, Grace C., 1896, *read* 1895.

In "Mazama" No. 1, p. 5, as also in the title of the frontispiece, the name of the Mazama or Mountain Goat, is given as *Haplocerus Montanus*. That name has become obsolete, and *Oreamnos Montanus* is now recognized as the true name. Inquiry from Dr. C. Hart Merriam as to the correct nomenclature brought the following valuable letter; from which it will be seen that the name *Mazama* cannot be applied to the Mountain Goat, except in a loose and popular way as a survival of an obsolete usage. But in

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that way the name is likely to continue to be used, and the more so since the name has been adopted by the society of Mazamas and by them given such popular fame.

WASHINGTON, D. C., June 18, 1897.

REV. EARL M. WILBUR,

Secretary MAZAMAS.

DEAR MR. WILBUR:

The information you wanted and which I promised you about the use of the name "Mazama," has proved a little more difficult to get together than I expected, and what I am sending you must be regarded as incomplete, though the synonymy accompanying is probably sufficient for your purpose. I am indebted to my assistant, Dr. T. S. Palmer, for assistance in this matter.

The uses of the word "Mazama" as a scientific name are as follows: In September, *1817*, it was published by Rafinesque in the American Monthly Magazine for a *genus* of South American deer. This being the first use of the name in a generic sense, it must stand, and cannot be used for any other genus, although it has been proposed for at least two others. Thus in *1837* it was applied by Ogilby to our North American antelope, and in *1850* by Gray to our Mountain Goat.

In *1827* it was used for a *subgenus* of deer by Hamilton Smith, and in the same year was used as a *specific name* for a species of "ovine antelope" named *Aplocerus mazama*, said to occur in the rocky forests and mountains of tropical America. What this animal is we do not know—possibly the Pudu. Going back to pre-Linnæan days, Klein (in 1751) speaks of a *Tragulus mazame*, and Seba of a *Tragulus temamaçama*.

The use of the word "Mazama" as a common or vernacular name seems to date from Fernandez in 1651. Mazame and Maçame are the forms used, and the name seems to have been applied to a Mexican deer or antelope, perhaps both. Lichtenstein, in a paper on Fernandez' Mammals, states that *Mazame or Maçame* is the plural of *Maçatl*, deer.

"Mazame" was used by Buffon, d'Azara, and others the latter part of the last and beginning of the present century, but in all cases seems to have been based on Fernandez. Doubtless many other references might be added, but pre-Linnæan literature is hardly in our line, and the necessary books are not at hand.

Very truly yours,

C. HART MERRIAM.

LIST OF SCIENTIFIC NAMES APPLIED TO THE MOUNTAIN GOAT (*Oreamnos Montanus*).*

1815. *Ovis montana* Ord, Guthrie's Geog., II. 292, 309.

1816. *Antilope* (*Rupicapra*) *americana* Blainville, Nouv. Bull. Soc. Philom., 73, 80.

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1817. *Oreamnos* † Rafinesque, Am. Monthly Mag., II.44.

1817. *Mazama ovina* Raf., Am. Monthly Mag., I.437.

1817. *Mazama sericea* Raf., Am. Monthly Mag., II.44.

1817. *Mazama dorsata* Raf., Am. Monthly Mag., II.44.

1818. *Rupicapra americana* Ord, Journ. de Phys., LXXXVII. 146-155.

1822. *Antilope americana* Desm. Mamm., II.478.

1822. *Antilope lanigera* H. Smith, Linn. Trans., London, XIII. 38, pl. IV.

1823. *Capra columbiana* Desmoulins, Dict. Classique d'Hist. Nat., III. 580.

1824. *Antilope lanata* H. Smith, Ferussac, Bull. Sci. Nat., 375.

1825. *Capra montana* Harlan, Fauna Am., 253.

1827. *Antilope* (*Aplocerus*) *lanigera* H. Smith, Griffith's Cuvier, V. 354.

1827. *Antilope* (*Aplocerus*) *mazama* H. Smith, Griffith's Cuvier, V. 354.

1829. *Capra americana* Rich., Fauna Bor., 268, pl. XXII.

1829. *Capra* (?) *columbiana* Fischer, Synop. Mamm. 1829, 487.

1835. *Aplocerus* Swainson, Nat. Hist. & Class Quad., 380.

1843. *Antilope* (*Haplocerus*) *lanigera* Wagner, Suppl. Schreber's Saugth. 462.

1845. *Capra lanigera* Schinz, Synop. Mamm., II. 468-469.

1850. *Mazama americana* Gray, Knowsley Menag., 19.

1850. *Aplocerus americanus* Turner, Proc. Zool. Soc. London, 174.

1852. *Aplocerus montanus* Richardson, Zool. Herald, Foss. Mamm., II. viii., 131-138.

1857. *Aplocerus lanigera* J. Wilson, Encyc. Brit., ed. 8, XIV. 211.

1858. *Haplocerus montanus* Baird, Am. Journ. Sci., XXVI. 145.

1869. *Aploceras montanus* Cooper, Am. Nat., II. 537-538.

1875. *Aplocerus columbianus* Coues & Yarrow, Wheeler Survey., V. 68.

1876. *Mazama montana* Gill, Int. Exhib., List Useful or Inj. Mamm., 5.

1878. *Haplocerus laniger* A. W.—Encyc. Brit., ed. 9, II. 102.

1895. *Oreamnos montanus* Merriam, Science, N. S., I. 19.

The following abstract of an address given by Dr. C. Hart Merriam before the Mazamas at the Auditorium in Portland, September 22, 1896, was considered so valuable for its suggestion of future lines of work for the society, that it is reprinted here.

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*Based mainly on Grinnell's synonymy in Forest & Stream, XXXIII. 384, Dec. 5, 1889.

†In speaking of the Mountain Goat, Rafinesque states: "This animal has been called *Ovis montana*, by Ord, but the genus *Ovis*, or rather *Aries*, has hollow and flat horns: this species, with the following and the *Mazama puda*, will form a particular subgenus (or perhaps genus), which I shall call *Oreamnos*, distinguished by the horns slightly curved backwards or outwards, often rough or annulated, and long hair, besides living in mountains."

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THE FIELD OF THE MAZAMAS.

"MAZAMAS: You have chosen a field in which your labors, your example and your influence are bound to benefit your fellow men. Your officers in their brief addresses have said many wise things. They have urged you to let your outings bear fruit—to contribute to the sum of human knowledge—and you have responded with an earnestness of purpose that is a credit to yourselves and to your State. As mountain climbers and explorers you have increased our knowledge of the geography and topography of the Northwest and stimulated the collection of accurate information respecting its natural history and resources. The first number of your publication, "Mazama," contains a fund of useful information, and, if I am correctly informed, the second will be even more valuable. These publications, of which you may well be proud, will carry the name and fame of the Mazamas to many lands and will give you rank among the useful scientific societies of the world.

In your summer excursions, go where you will, you cannot fail to be impressed by the need for better maps. You should keep this need perpetually before the eyes of your friends and legislators, and should exert your influence individually and collectively to secure more accurate topographic surveys and more reliable maps. Good contour maps form a basis for the intelligent development of a country. They are useful to every citizen who can read and write; they are of service to the ranchman and miner in locating their claims; they are money in the pocket of the railroad corporation seeking to lay out new lines, and of the shrewd merchant who understands the principles of commercial geography; they are indispensable to the scientist, the statistician and the political economist who desire to plat the results of their investigations. Without them it is impossible to show graphically the distribution of animals and plants, the position of coal fields and other mineral deposits, the relation of climatic conditions and soils to successful agriculture, the distribution of forests, deserts, and irrigable lands, the distribution of religions, nationalities, populations, and wealth, and the distribution of industries and productions with reference to the underlying conditions which determine the commercial success or failure of human enterprise. Who has not seen capital wasted and energy expended without return, for lack of knowledge of fundamental truths that may be learned from the intelligent study of accurate statistical and commercial maps? In short, good maps are worth ten times what they cost. They are needed by every one from the school child to the oldest citizen; our educational system is incomplete without them, and it should be considered discreditable to any commonwealth to neglect their construction. By cooperating with the general Government and paying half the cost of the field work, any state or territory may secure for itself the best possible large scale contour maps of its domain. A number of states have already availed themselves of this privilege. Cannot the *Mazamas* exert their united influence in having Oregon mapped under the same law?

But your field is not limited to 'geography'—at least in the old sense. The 'National Geographic Society,' of which some of you are valued members, has five departments: Geography of the Land, Geography of the Sea, Geography of the Air, Geography of Life, and Commercial Geography. These several departments embrace pretty much all the natural sciences—including geology, zoology, botany, meterorology and so on. Should the scope of the *Mazamas* be any less comprehensive? Few

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of you are trained in the paths of natural science, but all of you are energetic, wide awake, intelligent men and women—no others could be *Mazamas*—and in your outings you can *observe* nature and record what you see.

What naturalists need from little known parts of the land is a simple record of observations relating to the plants and animals. For instance, it is easily within the power of the *Mazamas* to tell us what trees grow on Mounts Adams and St. Helens, whether or not Goats, Sheep, or Marmots inhabit the summits of these mountains; and, if Marmots occur there, whether they are the yellowish brown kind like those on Mount Mazama and Mount Hood, or the monstrous hoary-gray kind like those on Rainier. Simple facts like these are genuine additions to knowledge and well worth recording. You have already given us lists of the plants of Hood and Adams, thereby making important contributions to botanical literature. Let it be your aim to do still more of this good work in future, and to go a step further by adding brief notes under the head of each species so we may know the zone it inhabits and the kind of place in which it may be found.

You are doing noble work in promoting the advancement of knowledge and encouraging scientific investigation in a land where for years to come commercial activity must necessarily dominate the more intellectual pursuits. It speaks well for Oregon that so early in her development she can boast an organization so potent for good. But you must not rest on your oars. You have a purpose and a task, and there is much uphill work before you. You should not only foster scientific inquiry and become the acknowledged center of information respecting the geography and natural history of your State; you should also strive to secure the erection of a state Museum, where your ethnological treasures, your geological strata, and your exceedingly interesting fauna and flora may be represented.

What is needed is not a heterogeneous assemblage of relics and specimens of animals and plants from all parts of the earth, but a *representative* collection of the natural history of the Northwest. Such a museum need not be housed, at first, in a costly building, nor need its support be an appreciable tax on the commonwealth. If thought advisable a small admission fee might be made to cover the cost of its administration. Oregon needs such a museum to display her natural resources and productions; you need such a museum for consultation; your children need such a museum as one of the educational advantages to which they are entitled. The educational value of properly arranged and labeled collections cannot be overestimated, and the time is not far distant when well selected types of the various groups of animals, plants, and minerals will be considered necessary adjuncts to our schools. Already the advantage of object lessons in natural science is universally recognized, and teachers, perhaps more than any other class of persons, must have access to collections for reference and study. It is not essential to begin on a large scale, for few things grow more rapidly than museums, when once the seed is fairly planted. Will not you, Mazamas, 'put your shoulder to the wheel' and establish the nucleus of a collection that will some day be the pride of Oregon?"

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Bibliography of Crater Lake.

The following bibliography (in addition to that on page 160) will serve for reference to some of the more important things that have been published about Crater Lake. It does not pretend to be exhaustive. References to increase it will be welcomed by the Publication Committee, and may be sent to the Secretary of the society.

U. S. Geol. Survey.

Eighth Annual Report, 1886-87. Part I. pp. 156-158.

Crater Lake Special Sheet, March, 1896, with text and illustrations.

Science. Vol. vii. 179, 1886. "Crater Lake, a Proposed National Reservation." Capt. C. E. Dutton.

National Geographic Magazine. Vol. vii. 33, February, 1897. "Crater Lake, Oregon." J. S. Diller. Illustrations and maps.

American Journal of Science. Vol. iii. 165, March, 1897. "Crater Lake, Oregon." J. S. Diller. Illustrations.

Revue Geographique Internationale (Paris), Vol. xxii. 169, August-September, 1897. "Le Lac-Cratere (Oregon)." J. S. Diller. Illustrations and maps.

Inland Educator (Terre Haute, Ind.), Vol. iv. 209, June, 1897, "Crater Lake." Barton Warren Evermann. Illustrations and maps.

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Morning Oregonian (Portland), September, 25, 1892. "An Oregon Model."

September 15, 1895. "Trip to Crater Lake." W. A. B[uchanan]. Illustrated.

March 16, 1896. "A Summer Outing."

January 21, 1897. "For a Natural Park."

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Morning Oregonian, August 12, 15, 22, 23, 25.

September 10. "Trip of a Lifetime." W. G. Steel. Illustrated.

Klamath Republican. August 27, 1897. "Crater Lake — Mazamas."

San Francisco Chronicle, October 11, 1896. "An Ascent of Mount Pit (*sic*) and a Visit to Crater Lake by the Mazamas." W. G. Steel. Illustrated.

New York Journal, September 20, 1896. "A Woman Mountain Climber's Exploits." Fay Fuller. Illustrated.

Tacoma Ledger, September 6, 1896. "Christened Mount Mazama." May Fuller.

Science, September 25, 1896. "Meeting of the Mazamas at Crater Lake, Oregon." C. H. Merriam.

Pacific Unitarian, October, 1896. "A Trip to Crater Lake." Earl Morse Wilbur.

Good Roads and Cyclist (Portland), October, 1896. "Awheel to Crater Lake." Earl Morse Wilbur. Illustrated.

Scientific American, December 5, 1896. "Crater Lake, Oregon." Earl Morse Wilbur. Illustrated.

Traveler (San Francisco), November, 1896. "The Mazamas at Crater Lake." W[inifred] W[atson]. Illustrated.

Add to bibliography of Mount Adams, "Mazama" No. 1., p. 111,

Goldthwaite's Geographical Magazine. Vol. v., Nos. 5 and 6. "The Snow Peaks of the Cascades." C. E. Rusk.

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List of Climbers of Mount Pitt.

The following list contains all names which it has been possible to obtain of persons who have climbed to the summit of Mount Pitt, up to the time of the Mazamas' ascent on August 16, 1896. No records had been kept, and only a few scraps of paper in an old can were found with names on them, together with a stick on which a few names had been carved. These relics were removed by the Mazamas, and are in the hands of the Historian; while a copper box was left on the summit, containing a record book, in which all previous names found were entered. Corrections and additions to this list are requested, and should be sent to the Secretary. The date named is that of the person's first ascent; the address is given as at the time of the ascent; and the State is understood to be Oregon, unless otherwise noted. Italics denote persons who have joined the Mazamas.

Addington, George B., Jacksonville..1891
Alexander, Arthur, Oakland, Cal...1886

Balcomb, Prof. E. E., Monmouth..1896
Balcomb, Mrs. E. E., Monmouth..1896
Barneburg, Peter, Phoenix.....1883
Beagle, J. H., Prospect.....1893

Cockerline, Herbert N., Eugene....1896
Cooper, Mrs. Jennie, Independence, 1896

Daley, Geo. W., Sr., Eagle Point..1882
Daley, Irwin,.....1893
Damon, Loren L., Medford.....1894

Eicher, Charles,.....1893
Emmitt, R. A., Keno.....1895
Erwin, John P., Iowa.....1886

Farmer, L.....1893
Fitzgerald, W. J.....1887

Gifford, Benjamin A., Portland.....1896
Gorman, Martin W., Portland 1896
Gray, William, Ashland..... . .1896

Angel, Charles W., Jacksonville....1891

Bronaugh, Earl C., Jr., Portland...1896
Burrows, Grant, Lebanon.....1895
Butler, William E., Ashland 1896

Cox, Prof. Ulysses O., Mankato, Minn.....1896

De Moss, Homer, Keno 1895
Dickens, Cyrus, ... 1884
Donaldson, Frank E., Oregon City.1896

Evermann, Prof. Barton W., Washington, D. C. 1896

Fuller, E. Fay, Tacoma, Wash.....1896

Griffiths, Benjamin, Kelso, Wash..1884
Grigsby, Lee.....1893

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Harman, William L., Portland 1896
Hayes, T. A., Independence 1896
Higginbotham, Cass, Eagle Point..1882

Jones, Garl T., Medford 1894
Jones, Harry, Keno.....1895

Kellogg, Clarence D., Medford 1894
Kerr, K. C., Washington, D. C....1886
Kerr, Mark B., Washington, D. C...1886

Leadbetter, Bertha C., San Francisco1896
Little, Francis C., Portland 1896

McBride, J. F., California.....1886
McDonough, J. W., Jacksonville....1885
McLaren, Charles, Red Bluff, Cal..1896
Mann, Frances, Zena.....1896
Mathes, Harry, Phoenix.....1883

Newman, Caroline N., Shreveport, La.....1896
Nicholson, A. C., Butte Creek.....1890

Parsons, Edward T., Chicago, Ill..1896
Patrick, W. A., Ashland.....1887
Patterson, George, Riverside, Cal...1865
Patterson, William, Ashland.....1865
Patton, W. S., Salem 1895
Pettekau, A. H., Keno 1895

Reed, Lottie, Portland 1896

Scott, Leslie, Portland.....1896
Shaw, Robert J., Ashland..... 1896
Shayver, W. F., Butte Creek.....1890
Sholes, Charles H., Portland 1896
Siebert, John S., Washington, D. C. 1886

Taylor, W. R.....1893

VanDyke, W. S., Phoenix.....1883

Watson, Thomas, Yreka, Cal.....1886
Watson, Winifred, Portland.....1896
Watt, Geo. H., Pullman, Wash.....1887
Whitman, Bert, Butte Creek.....1890

Youngs, D. S., Butte Creek.....1890

Total, 98.

Holton, H. N.....
Horton, J. N., Jacksonville 1894

Jones, J. C., Butte Creek.....1890
Jordan, Walter, Grants Pass. 1884

Klippel, John, Jacksonville.....1884
Klippel, Richard, Portland 1884

Love, George M., Jacksonville.....1894
Low, Stephen B., Klamath Falls...1884

Mathes, William, Phoenix.....1883
Middleton, Mrs. Sue A., Portland. 1896
Miller, Otto,.....1893
Moore, Rufus S., Klamath Falls ...1884

Nickerson, Roscoe, Klamath Agency1884
Norris, John R., Ashland.....1895

Pickens, Cyrus, Table Rock 1883
Pierce, Charles H., Jacksonville....1891
Pierce, Joseph G., Jacksonville 1891
Pittock, Helen L., Portland.....1896
Pittock, Henry L., Portland.....1896
* Priest, William.. 1887

Ricksecker, E., Washington, D. C. 1886

Smith, Amanda J., Portland 1896
Smith, Dr. C. K., De Smet, Idaho..1884
Sonnichsen, Monroe, Ashland..... 1887
Steel, William G., Portland 1896
* Stewart, William,.....1865

Turnham, William, Sams Valley...1884

Wilbur, Rev. Earl M., Portland....1896
Wright, S. R., Klamath Falls.....1895
Wilson, Albert, Klamath Falls.....1888
Wilson, Stanford, Klamath Falls...1888

* Deceased.

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Secretary's Report.

Number of members, Oct. 4, 1897.

Active,	202
Honorary,	8
Total (in 15 different States),	210

Since report published in last Bulletin, received,

For members' dues	$508.50
For sales of Bulletin No. 1	80.20
For lecture tickets	67.25
For sale of map	.05
Paid over to Treasurer	$656.00

Treasurer's Report.

RECEIPTS.

May 19, 1896.	To balance on hand as per last published report	$142.60
June 20, 1896.	To loan at Ainsworth National Bank	85.00
Oct. 1, 1897.	To received from Secretary to date	656.00
	To received from members' dues to date	2.50
		$886.10

DISBURSEMENTS.

By disbursements per vouchers as follows:

1896.		
May 22.	Longshore Printing Co. On Bulletin account	$ 75.00
May 26.	Peaslee Bros. Printing	5.50
	Geo. H. Cook & Co. Printing	2.75
	Geo. H. Cook & Co. Printing	1.50
	J. K. Gill Co. Stationery	2.45

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May. 26	Earl M. Wilbur. Secretary's office expenses (this heading includes postage, stationery, typewriting, and similar minor expenses)	9.29
May 27.	Longshore Printing Co. On Bulletin account	45.00
May 28.	Outing Publishing Co. Electrotype	5.00
June 11.	Earl M. Wilbur. Office expenses	12.45
June 15.	F. C. Little. Postage	3.75
June 17.	Longshore Printing Co. On Bulletin account	51.70
June 19.	Joaquin Miller. Lecture	33.50
June 20.	Longshore Printing Co. Balance on Bulletin account, etc.	88.83
June 22.	Marx & Jorgenson. Hall rent for lecture	15.00
July 3.	N. W. B. P. & A. Co. Bill-posting for lecture	6 00
	Weister Co. Lantern slides for lecture	4.00
July 11.	Earl M. Wilbur. Office expenses	6.55
July 24.	Geo. H. Himes. Printing	2.00
July 25.	Evening Telegram. Advertising lecture	2.00
	Peaslee Bros. Printing	6.50
July 29.	Morning Oregonian. Advertising lecture	25.25
July 31.	Earl M. Wilbur. Office expenses	6.70
Aug. 3.	Ainsworth Nat'l Bank. Interest on note	1.41
Aug. 11.	Longshore Printing Co. Printing	22.50
Sept. 3.	Earl M. Wilbur. Office expenses	7.90
Sept. 14.	Blake, McFall & Co. Account Geo. H. Himes, printing	23.25
Sept. 16.	Portland Chamber of Commerce. Room rent	2.00
Sept. 19.	Jesse Waddell. Painting water gauge for Crater Lake	2.50
Sept. 23.	Howe, Davis & Kilham. Mounting maps for Mt. Pitt	1.50
Sept. 28.	Ainsworth Nat'l Bank. Interest on note	.90
Sept. 29.	Morning Oregonian. Advertising	6.00
Oct. 1.	Adolph A. Dekum. Copper box for Mt. Pitt, etc	10.10
Oct. 2.	T. Brook White. Postage	6.50
	Stuart & Thompson Co. Blank books and maps	11.85
Oct. 3.	Woodard, Clarke & Co. Red fire for Crater Lake	6.60
	Longshore Printing Co. Printing	4.00
Oct. 23.	Marx & Jorgensen. Hall rent for annual meeting	12.50
Nov. 7.	Peaslee Bros. Printing	7.00
	Ellis Printing Co. Printing	7.25
	H. A. Webber. Music at annual meeting	12.00
Nov. 20.	Sealy, Mason & Co. Groceries for annual meeting	2.00
	L. L. Hawkins. Paid for services at annual meeting	2.50
	Earl M. Wilbur. Office expenses	5.05
	Portland Library Association. Room rent for lectures	10.00
	Morning Oregonian. Advertising lectures	8.00
Dec. 19.	E. B. Pickel. Account of transporting trout to Crater Lake	10.35
1897.		
Jan. 16.	Washington Creamery. Cream for annual meeting	2.50
	Earl M. Wilbur. Office expenses	3.80
	Ellis Printing Co. Printing	11.90

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